# PART III: SURFACE WATER ASSESSMENT

## Chapter One: Current Surface Water Monitoring Program

### *Overview*

Surface water quality monitoring undertaken by the Department during the 305b reporting period continued to support an assortment of water program activities. Long-term monitoring programs are designed to assess trends in water quality, as well as to generate baseline water quality information. The Department also maintains a strong presence on Lake Champlain and conducts a variety of short-term lake and stream-specific monitoring projects. Monitoring data is used to manage and protect Vermont waters in a pro-active manner.

The following describes the Department's current overall surface water monitoring program which is comprised of twenty-seven discrete projects. VDEC's monitoring efforts are classified herein as **physical/chemical**, **biological**, **volunteer** and **other**. Within each of these classes, monitoring projects are further described as 'core' (describes long-term projects), 'diagnostic studies' (intended to identify the cause of a particular water quality problem), and 'special studies' (monitoring studies intended to provide information and data on a specific water quality issue).

### PHYSICAL & CHEMICAL Monitoring

*Core Programs*

The ***Spring Phosphorus Program*** collects spring overturn nutrient, physical, and chemical data on Vermont lakes and ponds that are 20 acres in size or larger. Parameters include total phosphorus and total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi disk transparency, and multi-probe profiles (temperature, dissolved oxygen, conductivity, pH). Two hundred and thirty-two lakes have been monitored in conjunction with this program. Forty lakes have over ten years of project data and 12 of these lakes have fifteen or more years of data. The Spring Phosphorus database contains over 1500 records collected since1978. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in the Lake Inventory and stored in the long-term 'WQDATA' databases.

The ***Lake Assessment Program*** is designed to rapidly assess the extent to which lakes meet designated uses for 305b reporting purposes and to gather information to focus lake protection efforts. The degree of sampling intensity for assessment lakes varies with the degree to which impairment must be documented. In general, lakes are circumnavigated and detailed assessment observations are made regarding in-lake and shoreline conditions with respect to designated uses and threats to lake water quality. Detailed notes are made regarding the extent and composition of the macrophyte community. Sampling is performed for total phosphorus, alkalinity, Secchi disk transparency, and multi-probe profiling. Additional sampling may be performed as necessary to identify departures from Vermont Water Quality Standards. Since 1989, some 238 lakes have been assessed. Data from the project are summarized in the Lake Inventory and stored in the long-term 'WQDATA' databases. Information collected in conjunction with field visits is stored in the Lake Assessment database.

The ***River Assessment Program*** is designed to assess the extent to which rivers and streams support

designated uses for 305b reporting purposes and for focusing protection efforts. The assessment itself involves identifying, collecting, compiling, analyzing and evaluating all water quality data and information as well as point and nonpoint source pollution impacts on designated uses specific to the basins being assessed in any given year. VDEC presently conducts the majority of its assessments on a five-year rotational watershed basis. Rivers and streams in the basins of focus are visited to look for obvious sources of pollution from the land or indicators of problems or threats in streams such as sedimentation, heavy algae growth, or water with unnatural color or odor. A provider of much of this information is the VDEC ***Ambient Biomonitoring Program*** that conducts bioassessments to determine a waterbody's aquatic life use support and compliance with Vermont Water Quality Standards. Temperature, nutrients, pH, conductivity, and alkalinity are parameters commonly measured coincident with the biological sampling. The ***Ambient Biomonitoring Program*** monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized and stored in the long-term 'Biology' database. Data and information from the River Assessment Program is stored in the River Assessment database.

The ***Water Level Monitoring Program*** monitors lake surface elevations to establish mean water levels for a variety of purposes, most notably to help determine the jurisdictional boundary of the state's lakes and ponds encroachment permit program. This monitoring effort is not subject to an EPA-approved Quality Assurance Project Plan (QAPP). Data from the project are maintained in paper files.

***The Lake Champlain Long-Term Monitoring Program*** surveys the quality of Lake Champlain waters on a bi-weekly basis (May to November) at 12 locations throughout the lake. Eighteen major tributaries are sampled on an event basis as well. The program's large physico-chemical parameter list includes species of phosphorus, nitrogen and organic carbon; chlorophyll-a; base cations and alkalinity; total suspended solids; dissolved oxygen, conductivity; and pH. As of 1999, this program had assembled a database comprising 4,462 lake and 3,259 tributary sampling events. More data are currently available. This monitoring effort is subject to an EPA-approved QAPP. Data from the project are summarized in the Lake Champlain Monitoring Database and stored in the long-term 'WQDATA' databases.

***The Long-Term Monitoring (LTM) Acid Lakes Program*** collects chemical and biological data on lakes located in low alkalinity regions (those sensitive to acidification based on the bedrock buffering capacity) to determine the effects of acid deposition on Vermont's lakes. Nearly 200 lakes statewide were surveyed during the winters of 1980 through 1982 to identify the acid sensitive areas of the state. Eleven lakes selected from these areas are now included in the LTM Program and are sampled at least eight times every year for 16 chemical parameters related to acidification. Data is used to: 1) classify lakes according to their acidification status; 2) evaluate spatial and temporal variability in measured parameters; 3) track changes in acidification status over time as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen); and 4) evaluate impacts of acidification on aquatic biological communities. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in the 'AcidLake' database and are stored in the long-term 'WQDATA' databases.

***The Stream Geomorphic Assessment Program*** collects geomorphologic data on streams throughout the state for purposes of assessing stream geomorphic stability and developing regime relations for Vermont's streams. Stability assessments allow for the prediction of expected rates of river adjustment and an evaluation of the effects of various land and river management practices on geomorphic stability and physical habitat quality. Regime relations serve to guide stream protection, management, and restoration projects as well assisting VDEC in the establishment of Vermont-specific physical criteria for water quality classification and use attainment determinations. Parameters measured include channel dimension (cross section), pattern (meander geometry), longitudinal profile, channel substrate conditions, structure and composition of riparian vegetation, and floodplain and valley morphology. This effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in Microsoft Excel workbooks, and are stored in the Stream Geomorphology database.

*Diagnostic Studies*

Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past twenty years, Vermont has performed numerous such monitoring studies and the results of many of these studies have led to concrete remediation and correction steps. Lakes on which notable diagnostic studies have been performed include Harvey's Lake (Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg) and Lake Champlain. Presently, VDEC has active diagnostic studies on three recreationally used lakes (Lake Carmi in Franklin, Lake Parker in Glover and Ticklenaked Pond in Ryegate).

A wide variety of parameters are sampled in conjunction with diagnostic studies, with the actual tests performed specific to the project. Standard eutrophication parameters (phosphorus, Secchi transparency, dissolved oxygen) are always measured. Other parameters from both the sediment and the water column are measured as needed. Data from recent projects are summarized in the 'Lake Projects database' and are stored in the 'WQDATA' database. Data from the older projects are stored in the long-term 'WQDATA' databases.

One example study is taking place on Ticklenaked Pond located in Ryegate. Arising from a concerted effort by the Natural Resources Conservation Service (NRCS), a Ticklenaked Pond Watershed Association (TPWA) was formed to address what shoreline and watershed property owners perceive as declining water quality. Reduced clarity, algal scums and recurrent beach closures all have been noted by residents. In response to a request for technical assistance by NRCS and the TPWA, the Department added the pond to the state's listing of waters in need of assessment to determine if violations of the Vermont Water Quality Standards exist. Monitoring and research activities during the past two years included: bi-weekly depth profile monitoring for clarity, phosphorus and physio-chemical parameters; weekly citizen monitoring in the photic zone for transparency, phosphorus, and chlorophyll-a; a comprehensive biological assessment; and a paleolimnological analysis of the lake's sediments using elemental and stable isotopic carbon and nitrogen ratios as proxies for trophic condition. Recommendations for future action are being developed.

*Special Studies*

Special studies are those which are performed to gain more information about a particular environmental issue of importance to VDEC. There are presently four such projects being cooperatively managed by the Department.

1) The EPA-sponsored ***REMAP Assessment of Mercury in Sediments, Waters and Biota of Vermont and New Hampshire Lakes Project*** is a three-year effort to identify the lake types occurring in Vermont and New Hampshire which have elevated levels of mercury in fish and in upper trophic level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements; base cations and aluminum; and mercury in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component to the project that aims to determine the extent to which atmospherically deposited mercury has entered lakes in the study set. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from this ongoing project are stored in the 'REMAP' database, and will be stored in the long-term 'WQDATA' databases. Data from this project is being integrated with larger, synthetic data-review projects funded by EPA-ORD, and also by the Northeast Ecosystem Research Center.

2) The ***Lake Champlain Agricultural Best Management Monitoring Project*** is a seven-year project which was completed in 2001. This comparative observational study employed a three-way experimental design featuring one control and two treatment watersheds. Parameters measured included total phosphorus, total and Kjeldahl nitrogen, total suspended solids, and *E-coli*. Biological assessments were also performed on each of the three watersheds. The goal of this large project was to evaluate the efficacy of both low and high intensity whole-watershed BMP implementation strategies. This project was subject to an EPA-approved QAPP. Data from the project are presently summarized in spreadsheets and ultimately are to be archived to the EPA STORET system.

3) The ***Best Management Practices Effectiveness Demonstration Project*** is a stream monitoring effort designed to assess the efficacy of best management practices in controlling nonpoint source pollutant runoff. This cooperative VDEC-USGS project differs from the project described above in that it employs an upstream-downstream approach to pinpoint the reductions in pollutant runoff attributable to specific installed Best Management Practices. This project is being carried out on one agricultural stream (Little Otter Creek) and one urban stream (Englesby Brook) in the Lake Champlain Basin. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in an MS-Access© database and, once validated, will be stored in the long-term 'WQDATA' database.

4) In conjunction with the ***Paleolimnology of Vermont Lakes Project***, the Department is collaborating with the University of Vermont to develop a set of indicators of present and historical trophic status based on the paleolimnology of carbon and nitrogen stable isotopes ($d^{13}C$ and $d^{15}N$). Using cores from the sediments of several lakes, VDEC is working to identify the extent to which the present trophic conditions in these lakes deviate from the historic background. Such information will be instrumental in understanding the extent to which productivity (and thus phosphorus) has been elevated since the lake watersheds were first disturbed. Data from the project are summarized in the 'Lake Projects' database.

**BIOLOGICAL Monitoring**

*Core Programs*

The ***Ambient Biomonitoring Program*** conducted by biologists in VDEC's Biomonitoring and Aquatic Studies Section (BASS), was established in 1982 to: 1) monitor long-term trends in water quality as revealed in changes over time to ambient aquatic biological communities; 2) evaluate potential impacts from permitted direct and indirect discharges, Act 250 projects, nonpoint sources, and spills on aquatic biological communities; and 3) establish a reference database that would facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, the Department has used standardized methods for sampling fish and macroinvertebrate communities, evaluating physical habitat, processing samples, and analyzing and evaluating data. The program has led to the development of two Vermont-specific fish community Indexes of Biotic Integrity (IBI) and selected macroinvertebrate metrics. Guidelines have been developed for determining water quality classification attainment by using both macroinvertebrate community biological integrity metrics, and the IBI. Approximately 75 sites per year are assessed using fish and/or macroinvertebrate assemblages. Alkalinity, pH, conductivity, temperature and such measurements as substrate composition, embeddedness, canopy cover, percent and type of periphyton cover, and approximate velocity are routinely monitored. From 1985 to 1999, approximately 1,225 stream assessments were completed using macroinvertebrate and/or fish from about 850 wadeable stream reaches. This monitoring effort is subject to an EPA-approved QAPP. Data from the project are summarized and stored in the 'Biology' database.

The ***Aquatic Macrophyte Monitoring Program*** collects baseline information on aquatic plant communities in Vermont lakes by conducting descriptive surveys using a pre-established plant cover scale. This program has been active since the late 1970's, and information is available from hundreds of discrete surveys. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized and stored in the 'Lake Inventory' database. Paper files are maintained as well.

The Department of Environmental Conservation conducts numerous **Aquatic Nuisance Species Searches and Surveys** each year to search for new populations and monitor existing populations of nuisance aquatic species, primarily Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans*), zebra mussels (*Dreissena polymorpha*), and the wetland invasive purple loosestrife (*Lythrum salicaria*). This includes what is presently the longest ongoing zebra mussel monitoring program in the nation, the ***Lake Champlain Zebra Mussel Monitoring Program***. In conjunction with the zebra mussel program, 11 in-lake and 12 shoreline stations in Lake Champlain are monitored for larval and settler zebra mussel presence and density on a biweekly basis. In addition, adult zebra mussel surveys are performed at selected shoreline locations during late summer. As of 2001, there were 1,466 veliger records and 651 settler records within this program's data records. The Lake Champlain Zebra Mussel Monitoring Project is subject to an EPA-approved quality assurance project plan. Data from that project are summarized and stored in the 'ZebraMonitor' databases.

*Special Studies*

The ***Biodiversity Monitoring Program*** evaluates the status of selected biological species and communities. Specific activities include: 1) distribution surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened or endangered, or of special concern; 2) distribution surveys of other communities not currently listed but having species considered likely candidates for eventual listing (e.g. snails); and 3) monitoring of biological communities or community types whose diversity is threatened (e.g. Lake Champlain mussel and cobble/shale macroinvertebrate communities which are threatened by zebra mussels). Data are used to 1) describe species distribution; 2) identify species/communities at risk; and 3) develop management plans for the protection of identified species/communities. This monitoring effort is subject to an EPA-approved QAPP. Data from the project are summarized and stored in the 'Biology' database.

The ***Vermont Wetlands Bioassessment Project*** is a coordinated effort between VDEC and the Vermont Nongame and Natural Heritage Program to document and understand the biological and physical characteristics associated with seasonal pools (vernal pools) and northern white cedar swamps in Vermont. Since 1999, the project has collected biological, physical and chemical data from 28 seasonal pools throughout the state. Information collected on the invertebrates, amphibians, algae and plants associated with seasonal pools will be used to develop a biological monitoring program to assess and monitor the ecological health of seasonal pools in Vermont. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized and stored in the 'Biology' database.

The ***Lake Bioassessment Project*** is the principal vehicle by which biological criteria are being developed for Vermont lakes. This monitoring effort was originally launched in 1996 as a cooperative project with the State of New Hampshire. The project has developed consistent protocols by which the trophic status, and the phytoplankton, macrophyte, and macroinvertebrate communities in lakes can be measured. To date, 12 New Hampshire and 33 Vermont lakes have been included in the project. The goal of the project is to develop numeric measurements of the communities listed above to assess aquatic life use attainment. At present, trial multimetric criteria have been developed for the phytoplankton community and are in development for macrophytes and macroinvertebrates. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in the 'Lake Bioassessment' database, and stored in the 'Biology' database.

The ***Lake Champlain Long-Term Monitoring Program*** also performs biological sampling which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities. This monitoring effort, which is cooperative with New York State DEC, is subject to an EPA-approved quality assurance project plan. Data from the project are currently stored at NYSDEC.

Other ***Biological Monitoring Projects*** either ongoing or conducted on a periodic basis include:

- monitoring nontarget impacts to aquatic biota on lakes chemically treated in 2000 with SONAR® to control Eurasian milfoil infestations;

- monitoring the effects on both target and nontarget organisms of copper sulfate treatments to control the snails partially responsible for swimmer's itch in a pond; and
- monitoring the effects on nontarget fish and macroinvertebrates in those rivers subject to lampricide (TFM) treatments.

Activities for these projects are subject to the EPA-approved quality assurance project plan that applies to the Ambient Biomonitoring Network. Data from these projects are summarized and stored in the 'Biology' database.

***Northern Leopard Frog Surveys in the Lake Champlain Basin*** are the Department's response to reports of malformed frogs in the Lake Champlain Basin of Vermont in the summer of 1996. Malformed frogs were reported from twelve sites in five counties within the Lake Champlain Basin. Systematic field surveys were initiated in 1997 and targeted the northern leopard frog (*Rana pipiens*). The frequency and morphological characteristics of gross abnormalities among newly metamorphosed northern leopard frog populations have been recorded at 20 sites within the Lake Champlain drainage basin. VDEC has examined over 6,000 northern leopard frogs since 1996 and external malformations have been detected in 7.5% of the frogs examined. VDEC continues to gather data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within northern leopard frog populations at 10 established sites within the Lake Champlain Basin.

All findings are reported to the North American Reporting Center for Amphibian Malformations (**http://www.npwrc.usgs.gov/narcam/).** VDEC also continues to collaborate with the National Institute of Environmental Health and Sciences and the National Wildlife Health Center and other researchers, providing environmental samples and specimens to help further the malformed frog investigation. This project is subject to an EPA-approved QAPP. Data from this project are summarized and stored in the 'Biology' database.

## VOLUNTEER Monitoring

Citizen groups are becoming increasingly involved in monitoring, education, protection and restoration projects in Vermont. VDEC provides assistance and training to volunteers whenever possible. Watershed associations are presently active on numerous rivers and lakes in the state. Previous 305b reports discussed the fact that citizens groups are involved in stream and lake monitoring, education and restoration projects. Due to greater attention to the state's water quality, it is of utmost importance for citizens to continue to assist in this important work. The Department is most grateful to these dedicated citizens groups and will continue to provide technical assistance to them as much as possible. Appendix H is the directory of known watershed and lake association groups at work in Vermont.

*Core Programs*

***The Vermont Lay Monitoring Program*** equips and trains local lake users to measure the nutrient enrichment of lakes by collecting water quality data following a rigorously documented and quality assured methodology. This citizen monitoring program is mainly based on trophic parameters and monitors approximately 40 inland lakes and 25 Lake Champlain stations per year. All Lake Champlain stations and many inland lakes in the program are sampled for chlorophyll-a, total phosphorus and Secchi disk transparency. The remaining inland lakes in the program, from which limited data are needed, are sampled only for Secchi transparency. All sampling occurs on a weekly basis during the summer. Since the development of the Lay Monitoring Program in 1979, data has been generated on 91 lakes and 36 Lake Champlain stations. Fifty-six inland lakes and 36 Lake Champlain stations have five or more years of full season data. In addition to their standard monitoring, Vermont's citizen lake monitors also assist in the ANS Watchers Program (see below), and in collecting data for the Lake Bioassessment Program. This program is subject to an EPA-approved quality assurance project plan. Data are summarized in the 'Laymon' database, and stored in the 'WQDATA' database.

The ***Citizen Lake and Watershed Survey Program*** provides survey sheets and technical training for volunteers, lake and watershed associations, and other interested groups to enable them to perform screening level assessments to identify potential nonpoint sources of pollution to lakes by conducting in-lake, lakeshore, and lake watershed surveys. Information gathered in conjunction with this program is stored in paper files. An excellent example of one such program activity is the ***Lake Parker Watershed Protection Project***. In conjunction with this project, a dedicated group of local volunteers has surveyed the Lake Parker watershed and is in the process of implementing projects in the watershed to reduce nutrient and sediment runoff to the lake. VDEC is providing technical assistance to this effort and is studying the lake to help the group decide on an achievable in-lake water quality goal for this lake protection project.

The ***Aquatic Nuisance Species (ANS) Watchers Program*** trains citizen volunteers to monitor for the presence of important nonnative aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, and zebra mussels. There are presently 124 ANS Watchers throughout Vermont. Information gathered in conjunction with this program is stored in paper files.

The ***Volunteer Acid Precipitation Monitoring Program*** was initiated in 1980 to assess the impact of the 1970 Clean Air Act which mandated the improvement of air quality in the vicinity of Midwestern and southeastern fossil fuel burning plants. Dedicated volunteers at six sites throughout Vermont (Holland, Morrisville, Mt. Mansfield, St. Albans, St. Johnsbury and Underhill) collect precipitation samples on an event basis. The volume and pH of each storm event is recorded. Additional parameters such as conductivity and wind direction are recorded at individual stations. This data is used to: 1) assess spatial and temporal variability in the pH of bulk precipitation; and 2) assess changes in the pH of bulk precipitation over time and as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen). This program is subject to an EPA-approved quality assurance project plan. Data are summarized in the 'Acidrain' database and are stored in the long-term 'WQDATA' database.

**OTHER Monitoring**

***The Fish Contaminant Monitoring Program*** is managed by VDEC and performed in cooperation with the Vermont Department of Fish and Wildlife and the Vermont Department of Health (VDOH). Edible tissue from game fish acquired throughout the state is analyzed for mercury and other contaminants and these data are used in the setting and subsequent refinement of VDOH fish consumption advisories. This project is subject to an EPA-approved quality assurance project plan. Data are summarized and stored in the 'Vermont Fish Contaminant Monitoring' database. This is considered a core monitoring project.

**Data Interpretation & Communication**

The information from the rotational assessments is incorporated into the Water Quality Assessment database. From the database, reports are generated for waterbodies in river basins for 305b annual electronic reporting as well as biennial reports, general information, review and feedback purposes. Feedback is requested from the district fisheries biologists, watershed association leaders, US Forest Service fisheries biologists, NRCS and the local USDA working groups.

The lakes portion of Vermont's 305b Assessment database continues to be fully compliant with the most recent version of the EPA's ADB 305b database. The lakes portion of the database contains rigorous error and redundancy checking and has a number of programmed queries to facilitate not only electronic reporting to EPA via its contractor RTI but also to automate the preparation of required tables.

Beginning with the 1996 report, Vermont's 305b Water Quality Assessment Reports have been placed on the Department's web site and are available to any member of the public with internet access. This has saved considerable paper resources and duplicating costs.

**Plan for Achieving Comprehensive Assessments**

Vermont's watershed management and assessment approach to water quality planning, as outlined in Appendix C, plus the state's rotational watershed assessment procedure (see narrative in Chapter Two below), constitutes Vermont's plan for achieving comprehensive assessments.

## Chapter Two: Assessment and Listing Methodology and Mapping Approach

### *2001 River and Lake Water Quality Assessment Methodology*

Several years ago, Vermont adopted a rotational watershed assessment strategy for the purposes of assessing and reporting water quality information. The state has been divided into 17 major planning basins that have from four to 22 river sub-basins and main stem segments within them. The surface waters within these sub-basins are referred to and have been designated as 'waterbodies.' There are 210 river and 556 lake designated waterbodies in Vermont. VDEC plans to assess the waters of all 17 major basins at least once every five years. By focusing annual evaluations on selected watersheds, more systematic and intensive efforts can be made to collect and evaluate information on nonpoint and point sources of pollution.

The assessment itself involves identifying, compiling and evaluating all available water quality data and information as well as point and nonpoint source pollution impacts on designated uses specific to the basins being assessed in any given year. The data are maintained in MS-Access© databases which are specifically designed to be consistent with EPA's current Assessment Database package. Vermont relies on the following sources of data and information in assessing designated use support:

1) VDEC Water Quality Division (monitoring data)

2) VDEC Wastewater Management Division (WWTF permit compliance)

3) VDEC Waste Management Division (solid & hazardous waste site monitoring data)

4) Vermont ANR Enforcement Division (violations of water quality standards)

5) Vermont Department of Fish & Wildlife (game fish data, temperature data, studies)

6) Vermont Department of Health (beach closure information and fish consumption risk assessments)

7) Vermont Department of Forests, Parks, and Recreation (bacteriological testing and beach closure information)

8) Vermont Department of Agriculture (agricultural water quality violations)

9) Vermont Regional Planning Commissions (known locations of problems)

10) USDA Natural Resource Conservation Service (agricultural nonpoint sources and locations of pollution abatement projects)

11) Citizens and citizen associations (citizen monitoring data, location of sources, complaints)

12) US Geological Survey Water Resources Division (monitoring and research)

13) US Forest Service (fish habitat and water quality data and information)

14) US Environmental Protection Agency (monitoring and research)

15) US Army Corps of Engineers (Environmental assessments of Project waters)

16) University of Vermont and Vermont State Colleges System (monitoring and research)

VDEC's ambient biomonitoring network (ABN) provides most of the data used in the assessment of monitored river miles (see more complete description below). VDEC's lakes and ponds program provides most of the data used in the assessment of monitored lake acres. The other sources listed above provide fewer and more widespread data points.

Evaluated information used for assessments includes desktop modeling, some lay monitoring data, best professional judgement of resource managers, known sources of pollution, and analytical results that exceed five years in age.

*Biological Assessments*

Assessment of biological integrity is conducted on the state's rivers and streams for the purpose of trend detection and site-specific impact evaluation. Macroinvertebrate and/or fish populations of rivers and streams are assessed by comparing a series of biometrics measuring community structure and function to a set of biocriteria that represent the biological potential for the ecoregion/habitat being evaluated. The biomonitoring activities can be placed into two categories; 1) long-term monitoring of reference level sites and 2) site specific impact evaluations.

The biological potential for various sites is established through long term reference site monitoring. Information from this program element also serves to refine existing biocriteria and detect trends in baseline biological integrity. The long-term monitoring is conducted on a set of reference sites on a 5-year rotating basis, so as to give five years of continuous data for each site. Sites are stratified across stream ecotypes differing in drainage area size, elevation, and alkalinity. Human activity in reference site drainages is judged to be minimal relative to other streams in the ecoregion.

Where site-specific impact assessments are conducted, potential pollution sources are spatially bracketed with sample sites to determine impact/non-impact on the aquatic biota attributable to the pollution source. Either macroinvertebrate or fish populations or both may be sampled. Approximately 50 river sites are assessed each year in the late summer-early fall (Sept-Oct15) on a five year rotational watershed basis. From 1982 to 2000, the state has evaluated over 1,000 sites.

Detailed biological assessment procedures for wadeable streams are available on request. Trial biological criteria procedures have also been developed for plankton communities within Vermont lakes, and are used in corroborating assessments of Aquatic Life Uses. Other biological assemblages are being evaluated for assessing lake biological integrity as well. Macroinvertebrate and amphibian community indices are also being evaluated for use as biomonitors of aquatic life use support for intermittent wetlands.

*Use Support Determinations for Rivers and Streams*

The following paragraphs provide the reader with specific criteria and other information VDEC uses to determine use support for individual designated uses and make an assessment of water quality in rivers and streams. Information is presented to show how the water quality monitoring data and information relates directly to the degree of use support for 305b reporting purposes.

*1. Aquatic Biota/Habitat (Aquatic Life)Use*

Biological Monitoring

- FULL SUPPORT: Overall macroinvertebrate or fish community biological integrity is good, very good or excellent as determined by the Vermont Water Quality Division ABN program. (See above for elaboration of ambient biomonitoring program and metrics)
- PARTIAL SUPPORT: Overall macroinvertebrate or fish community biological integrity is rated fair by the Vermont Water Quality Division ABN program.
- NON SUPPORT: Overall macroinvertebrate or fish community biological integrity is rated poor to very poor by the Vermont Water Quality Division ABN program.

Habitat Assessment

- FULL SUPPORT: High quality habitat. All life-cycle functions, including overwintering and reproductive requirements are maintained and protected. Depending on the classification (A1, A2, B1, B2, B3) minimal to moderate changes from natural or reference condition. All B waters not as Types 1,2 or3 must exhibit no change from reference conditions that would have an undue adverse effect on the composition of the aquatic biota, the physical or chemical nature of the substrate or the species composition or propagation of fishes. Stream condition is stable or in transition to stable as determined using accepted geomorphic assessment techniques.
- PARTIAL SUPPORT: Physical habitat changes do not support optimum overwintering and reproduction for the aquatic life. Depending on the classification, changes to the habitat are greater than minimal to moderate. There is an undue adverse effect on the physical nature of the substrate. Stream condition is in transition to unstable with moderate loss of floodplain connectivity; or moderate to major planform adjustment that could lead to channel avulsions as determined using accepted geomorphic assessment techniques.
- NON-SUPPORT: Habitat alteration of the same nature as above however, much more severe or extreme in degree. Stream condition is unstable with significant channel and floodplain modifications that have altered the channel dimension, pattern and/or profile such that the stream is not in balance with the flow and sediment produced.

Conventionals (temperature, dissolved oxygen)

- FULL SUPPORT: Temperatures support coldwater species if waters are designated a coldwater fishery. Also the total increase from the ambient temperature due to all discharges and activities is not known to exceed 1.0 F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities shall not exceed the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery). Applicable dissolved oxygen levels support

coldwater or warmwater species, as defined by the Standards.

C PARTIAL SUPPORT: Temperatures are too high to fully support coldwater fish species in waters designated as a coldwater fishery - one or more trout species limited in number or biomass as compared to reference condition.

C NON-SUPPORT: Temperatures are so high that trout species are essentially absent (coldwater only).

• PARTIAL SUPPORT or NON-SUPPORT: The total increase from the ambient temperature due to all discharges and activities exceeds 1.0 F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities exceeds the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery). Fluctuations in applicable dissolved oxygen levels below the minimum values pertaining to coldwater and warmwater fish habitat.

Toxicants (priority pollutants, metals, chlorine and ammonia)*

C FULL SUPPORT: *For any one pollutant, no more than 1 exceedance of acute criteria (EPA's criteria maximum concentration or applicable State criteria) within a 3-year period, based on grab or composite samples and no more than 1 exceedance of chronic criteria (EPA's criteria continuous concentration or applicable State/Tribal criteria) within a 3 year period based on grab or composite samples.*

C PARTIAL SUPPORT: *For any one pollutant, acute or chronic criteria exceeded more than once within a 3-year period, but in less than 10 percent of samples*.

C NON-SUPPORT: *For any one pollutant, acute or chronic criteria exceeded in greater than 10 percent of samples.*

*Note: The above assumes at least 10 samples over a 3 year period. If fewer than 10 samples are available, the State should use discretion and consider other factors such as the number of pollutants having a single violation and the magnitude of the exceedance(s).*

(*) Portions in italics are from the 1998 federal guidance on 305b use support determination or subsequent guidance.

2. *Fish Consumption Use**

C FULL SUPPORT: *No fish consumption restrictions or bans are in effect.*

• FULL SUPPORT BUT THREATENED: *"Restricted consumption" of fish in effect (restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species); or a fish ban in effect for a subpopulation that could be at potentially greater risk, for one or more fish species; but no waterbody specific data*.

C PARTIAL SUPPORT: *"Restricted consumption" of fish in effect (restricted consumption*

*is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species); or a fish ban in effect for a subpopulation that could be at potentially greater risk, for one or more fish species and there is fish tissue data from the waterbody in question*.

C NON SUPPORT: *"No consumption" fish ban in effect for general population for one or more fish species; or commercial fishing ban in effect.*

(*) Portions in italics are from the 1998 federal guidance on 305b use support determination or subsequent guidance.

3. *Swimming/Contact Recreation*

Bacteria/E. Coli

C FULL SUPPORT: Geometric mean of samples taken not greater than 77 organisms/100 ml.

C FULL SUPPORT BUT THREATENED: If only one or two samples are available so that calculating a geometric mean is not possible but single samples are sometimes greater than 77 organisms/100 ml. and sometimes not

C PARTIAL SUPPORT: Geometric mean met sometimes and not other times in a given stretch.

C NON-SUPPORT: Geometric mean not met for all sampling sites in a given stretch.

Note: Data for at least two seasons is usually necessary to make non-support and partial support determinations. The time at which the sample is taken is also considered. If the numbers are high, the data are limited in scope, and the sampling was done during a high flow event then the situation is considered less of a problem then if the numbers are high, the data show this over a number of sample dates and seasons and the high numbers occur during high and low flows.

In addition, the following parameters may be used to determine support of contact recreation: turbidity, odor, abundance of algal growth and flow.

*4. Secondary Contact/Non-Contact Recreation*

C FULL SUPPORT: Water quantity and quality sufficient for boating, wading and fishing.

C PARTIAL SUPPORT: Boating or fishing limited by flows, odor, color, plant growth, or a diminished fishery.

C NON SUPPORT: Lack of water for boating, or fishing; or water quality of such poor quality that the fishery is almost non-existent; or unnatural plant growth so extreme that boating is not possible.

Note: Partial or non-support due to algal or other plant growth is used only if VDEC is reasonably confident the plant densities are not natural.

*5. Drinking Water Supply**

• FULL SUPPORT: *Drinking water use restrictions are not in effect.*

- PARTIAL SUPPORT: *Drinking water use restrictions resulted in the need for more than conventional treatment with associated increases in cost.*
- NON SUPPORT: *Drinking water use restrictions resulted in closures.*

(*) Portions in italics are from the 1998 federal guidance on 305b use support determination or subsequent guidance.

*6. Aesthetics*

C FULL SUPPORT: Water character, flows, water level, be and channel characteristics, exhibiting good to excellent aesthetic value. Water clarity and substrate condition good. No floating solids, oil, grease or scum. Intact, natural riparian zone.

C PARTIAL SUPPORT: Aesthetic quality compromised somewhat. Water unnaturally turbid. Moderate unnatural plant growth. Small or disturbed riparian zone.

C NON-SUPPORT: Aesthetic quality poor. Water is frequently and unnaturally turbid. Excessive unnatural plant growth covers the channel bottom, rocks or water surface. Substrate unnaturally silt-covered or mucky. Presence of floating solids, scum, oil or grease. Stained channel rocks. No riparian vegetation or a highly degraded riparian zone. Unnatural, slumping banks.

*7. Agricultural Water Supply and Industrial Water Supply*

C There are currently no EPA definitions or state standards for agricultural and industrial water supply. These uses are currently unassessed.

*8. Overall*

- FULL SUPPORT: All individual designated uses are fully supported and there are no known exceedances of State Water Quality Standards
- PARTIAL SUPPORT: One or more uses are partially supported and the remaining uses are fully supported
- NON-SUPPORT: One or more uses not supported

*Use Support Determinations for Lakes and Ponds*

In concert with regional consistency efforts undertaken during 1999 by the New England Interstate Water Pollution Control Commission, VDEC has made minor modifications to its methods for determining degree of use support for lakes. The following is a summary of the decision criteria used by VDEC to assess use support for lakes. Partial Support and Non Support use determinations are no longer made based solely on public opinion, town clerk, or Fish and Wildlife warden comments. Lacking any scientifically derived supporting data, comments such as those are only used to indicate a potential threat to a use.

*1. Aquatic Biota/Habitat (Aquatic Life)*

<u>Biological Assessment</u>

Until recently, very little biological assessment data has been available for lakes, except for a rather comprehensive, long-term database describing the distribution of aquatic macrophytes in lakes. Past assessments often relied on qualitative observations of habitat conditions, in some cases using the aquatic macrophyte data.

VDEC is in the final stages of developing a multimetric biological index based on phytoplankton communities, and is also developing a multimetric index to describe the condition of macroinvertebrate communities within lakes. It is anticipated that future assessments will be more directly based on biological data for phytoplankton, macrophyte, and macroinvertebrate assemblages. Insofar as sufficient data are available, Aquatic Life Use Support decisions are made consistent with the existing methods detailed in the Vermont 1996 Water Quality Assessment 305b Report. Where data are available, results of phytoplankton community assessments are being incorporated into the assessments of individual lakes. As of the date of this writing, a series of newly derived, trial criteria for macroinvertebrates is being tested.

Presumed Aquatic Life Use Attainment for Fluctuated Reservoirs

Reservoirs present a special case in regards to assessment of Aquatic Life Use Support. In the absence of direct biological measurements, Aquatic Life Use Support is assessed using the following decision making 'tree.'

1) Can the level of the waterbody be regulated by an artificial structure (e.g. dam, sluice, wier)?

   Answer is NO: no threat to ALUS due to water level fluctuation.

   Answer is YES: go to 2.

2) Is the waterbody connected to a licensed or unlicensed hydroelectric generating system, a flood control system, or subject to promulgated Vermont Water Resources Board rules regulating the fluctuation?

   Answer NO: a threat to ALUS could exist, but the threat must be verified by direct assessment before the waterbody is assessed as threatened.

   Answer YES: go to 3.

*3)* Is the waterbody regulated by a CWA Section 401 water quality certification issued after January 1, 1990?

   Answer NO: go to 4.

   Answer YES: go to 5.

4) Is the waterbody in fact subject to periodic fluctuations that are attributable to operation or manipulation of the outflow structure?

   Answer NO: a threat to ALUS is presumed to exist, due to the ability of the outflow operators to fluctuate water levels if the need arises, which can negatively impact littoral zone communities. Littoral zone impacts will have cascading effects within the remaining

trophic web of the waterbody. Accordingly, all of the waterbody's acreage will be assessed as threatened for ALUS.

Answer YES: Review maximum and mean waterbody depth, and shoreline development index (which relates to the linear distance of littoral zone potentially impacted). Evaluate the proportion of the littoral zone affected by the drawdown regimen. Review available biological data, in particular the presence and distribution of aquatic macrophytes within the littoral zone, where these data are available. Go to 5.

5) Does there exist a sufficient area of littoral habitat below the drawdown zone to enable establishment of a viable and stable aquatic community while accommodating the drawdown regimen, **or**, does available biological data suggest that a viable and stable aquatic community exists within the drawdown zone?

Answer NO: ALUS is partially supported. Littoral zone impacts of this magnitude will have cascading impacts throughout the remaining trophic web. Accordingly, the entire acreage is assessed as partially supporting. Direct biological assessment is warranted to upgrade this waterbody to threatened status.

Answer YES: a threat to ALUS is presumed to exist, due to the negative impact incurred by the littoral zone habitat actually subject to the drawdown. Littoral-zone impacts will have cascading effects within the remaining trophic web of the waterbody. Accordingly, all of the waterbody's acreage is presumed to be threatened for ALUS.

<u>Conventionals (alkalinity, DO)</u>

· FULL SUPPORT: Acid neutralizing capacity (ANC) greater than or equal to50 ueq/l during the spring runoff period.

Reliable data indicates that hypolimnetic dissolved oxygen minima are non-persistent. In addition, epi- and metalimnetic dissolved oxygen concentrations show depression below Vermont Water Quality Standards in less than ten percent of samples.

· PARTIAL SUPPORT: Reliable long-term monitoring data indicates that ANC routinely drops below 50 *u*eq/l (2.5 mg/l as CaCO3) during the spring runoff period.

Reliable long-term monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration periodically falls to (or near) zero mg/l or zero percent saturation during peak summer stratification **and** the hypolimnetic sediments are devoid of a macroinvertebrate community as determined by a rapid bioassessment procedure. The area designated as partially supporting aquatic life uses is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area. If, in the best professional judgement of VDEC scientists, the dissolved oxygen deficit is due to natural causes, aquatic life uses will be considered fully supported but threatened instead. The epi- and metalimnetic lake waters will be considered Partially Supported if dissolved oxygen concentrations fall below Vermont Water Quality Standards in ten or more percent of samples.

- NON SUPPORT: Reliable long-term monitoring data indicates that a lake's acid neutralizing capacity routinely drops below 0 *u*eq/l (0 mg/l as CaCO3) during the spring runoff period.

  Reliable long-term monitoring data indicates that, for the entirety or the majority of a lake's acreage, dissolved oxygen concentrations seasonally fall to zero mg/l or zero percent saturation during peak summer stratification and fish kills result.

- THREATENED: Reliable long-term monitoring data indicates that a lake's acid neutralizing capacity routinely drops below 250 *u*eq/l (12.5 mg/l as CaCO3) during the spring runoff period.

  Reliable long-term monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration periodically falls to (or near) zero mg/l or zero percent saturation during peak summer stratification, but macroinvertebrates are present. The area designated as threatening aquatic life uses is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area.

Non-Native Species:

Non-native species such as Eurasian milfoil (Myriophyllum spicatum), water chestnut (Trapa natans), and zebra and quagga mussels (Dreissena spp.) have been determined by VDEC to be a biological pollutants which have to have significant impacts on existing macrophyte and benthic macroinvertebrate communities.

- FULL SUPPORT: No established population of an invasive, non-native nuisance species.

- PARTIAL SUPPORT: Non-native species present in densities sufficient to alter littoral communities. The overall density is classified as "moderate" by VDEC.

- NON SUPPORT: Non-native species present in densities classified by VDEC as "heavy," which is considered sufficient to preclude the establishment of expected, native littoral communities.

- THREATENED: Non-native species present, but in low densities. In the case of Eurasian milfoil, lakes with a ten mile radius of an infested lake are considered Threatened, unless access the lake is remote or inaccessible by conventional means.

Nutrients

VDEC has segment specific nutrient criteria for Lake Champlain and Lake Memphremagog. As promulgated by US EPA (GPO 2001a), Vermont will work with US EPA New England to develop scientifically sound nutrient criteria for other Vermont waters for inclusion into Vermont's Water Quality Standards by 2004. Vermont's final nutrient criteria will also address Swimming and Aesthetic Uses.

*2. Fish Consumption*

New guidance on assessment of fish consumption use attainment (US EPA, 2000) is now being used to revise Fish Consumption use support on a lake-by-lake basis, as each lake is reassessed. Vermont interprets the US EPA guidance on fish consumption use attainment in the following manner: For any lake on which a species is present which is the subject of a 'no-consumption' advisory for a sub-population (women of childbearing age or children), fish consumption use is considered only partially supported. Any lake on which a no-consumption advisory is in place for the general population would be assessed as not supporting fish consumption uses. For lakes on which fish consumption is limited, but not banned, for a sub-population and/or for the general population, the use is considered supported. This is because fish can indeed be consumed from those waters, albeit at a reduced rate.

As of this writing, US EPA has promulgated new criteria for methylmercury in fish tissue, and ASWIPCA is currently preparing an implementation plan for this criterion. In addition, US EPA is issuing revised, national level general consumption guidelines for non-commercial freshwater fish. VDEC's present assessment methodology may change based on a review of these new criteria and guidelines.

The following summarizes the current assessment guidelines for fish consumption use:

- FULL SUPPORT: No fish consumption bans are in effect for the general population (limited consumption advisories may apply).
- PARTIAL SUPPORT: For a given species, a 'no consumption' advisory is in place for a designated sub-population (e.g., children or women of childbearing age).
- NON SUPPORT: For a given species, a 'no consumption' advisory is in place for the general population, or a commercial fishing ban is in place.

Under these guidelines, fish consumption use is considered Not Supported or Partially Supported only in the event that the fish species subject to the consumption advisory is documented by the Vermont Department of Fish and Wildlife to exist in the lake.

*3. Swimming Uses*

Swimming uses are assessed based on beach closures, resulting from bacterial contamination, or due to the presence of non-native aquatic nuisances such as Eurasian milfoil, water chestnut, or zebra mussels. For beach closures, the acreage occupied by the beach tested is identified as not fully supporting. For non-native nuisance species, the area impaired by the infestation is identified as not fully supporting.

- FULL SUPPORT: No beach closures are in effect during the assessment cycle. Non-native nuisance species absent or present in light densities.
- PARTIAL SUPPORT: No more than one beach closure per year, of less than 1 week duration. Non-native nuisance species present, but at densities which do not entirely preclude swimming uses. Areas where routine harvesting of non-native macrophytes

controls densities may be considered Partially Supported.

- NON SUPPORT: On average, one beach closure per year, of greater than one week duration, or, more than one beach closure per year. Non-native nuisance species present in such densities as to preclude swimming uses. Typically, these areas are characterized by greater than75% cover of a non-native macrophyte.

*4. Secondary (Non-Contact) Recreation*

C FULL SUPPORT: Water quantity and quality sufficient for boating, wading and fishing.

C PARTIAL SUPPORT: Boating or fishing limited by flows, odor, color, plant growth, or a diminished fishery.

C NON SUPPORT: Lack of water for boating or fishing; or water of such poor quality or unnatural plant growth so extreme that boating is not possible.

*5. Drinking Water Supply*

The Safe Drinking Water Act (SDWA) criteria for finished water are now being used to assess Drinking Water Supply use. A waterbody is considered not fully supporting only in the event that violations of SDWA criteria are found in finished, supplied drinking water. The process for assessing these uses is completely characterized by US EPA (2001).

*6. Agricultural Water Supply and Industrial Water Supply*

There are currently no EPA definitions or state standards for agricultural and industrial water supply. These uses are currently unassessed and will likely be removed from future versions of Vermont's Assessment Database.

*7. Aesthetics*

A closer look is presently being taken at the reliability of the information used to make this use support assessment and what the correct threshold level should be for considering aesthetic uses as only partially supported or not supported. The guidelines for assessing Aesthetic Uses for rivers may also be applied to lakes.

*8. Additional Considerations for Lake Champlain and Lake Memphremagog*

Vermont's Water Quality Standards contain segment-specific total phosphorus criteria for Lake Champlain and Lake Memphremagog. These scientifically-derived, lake segment-specific standards are used to evaluate Aesthetics and Swimming Use Support for each segment.

*9. Overall Uses*

- FULL SUPPORT: All individual designated uses are fully supported and there are no known exceedences of Vermont Water Quality Standards, in frequencies exceeding those established for the individual uses discussed above.
- PARTIAL SUPPORT*:* one or more uses are partially supported and the remaining uses are fully supported.
- NON SUPPORT*:* one or more uses are not supported.

***Clean Water Act Section 303d Waters***

The Department has begun to prepare the Vermont Year 2002 303d List of Waters. The Year 2002 listing will be assembled in a format similar to the EPA-approved Year 2000 List of Waters. Part A of the Year 2002 List of Waters will identify impaired waters in need of a Total Maximum Daily Load (TMDL) determination. Part B of the Year 2002 List of Waters will identify candidate waters for 303d "de-listing." Candidate waters for "de-listing" will be in one of two categories - waters no longer considered to be impaired and impaired waters that do not need or require a TMDL. The Year 2002 303d List of Waters will also contain a third component and identify impaired waters being addressed under an EPA-approved TMDL.

Following an opportunity for public review and comment, the final three-part Vermont Year 2002 listing will be submitted to the New England regional office of US EPA for approval by October 1, 2002. As a result of the 2002 listing process and timeline, such information will be made available separately.

***Geo-referencing, Database-GIS Linking, and Mapping***

The Department maintains geographic data layers for rivers and streams, lakes and ponds, wetlands, and ground water resources. During the reporting period, the Department geo-referenced the lakes and ponds data layer to the 1:24,000 scale. In addition, a reasonable streams data layer exists at the 1:100,000 scale. Mapping the rivers and streams data layer, even at the 1:24,000 scale, remains a goal which will take at least one additional 305b assessment cycle.

For purposes of presenting 305b assessment geographically, the Department uses the existing lakes and ponds, and rivers data layer, on a PC-ArcView (v3.1, ESRI) platform. Over the course of the reporting period, waterbody identification codes and waterbody names were geo-referenced within both data layers (this had been partially completed for lakes and ponds as of the 2000 305b report, but not at all for streams). Vermont is now in a position to provide maps of the locations of waterbodies, along with their 305b assessment findings, for all designated uses. Maps of overall use support for rivers/streams and lakes/ponds are provided in Chapters III-4 and III-5, respectively. Additional tasks remain in order to bring the streams data layer to the point that individual segments within waterbodies can be geographically referenced using the GIS-Assessment database linkage. Specifically, individual waterbody segments impaired for specific uses need to be identified within the rivers assessment database. These same segments will then need to be identified in the streams data layer. While there are several reasons why segmentation and stream layer improvement is not

yet complete, the geo-referencing of existing waterbody identification codes and the resulting ability to cross-query to both the lakes and streams assessment databases, is a significant step forward for Vermont.

Presently, VDEC biennially revises a database used for identifying 303d listed waters, which is separate from the streams database used to map 305b findings. While this may not be the most efficient method to maintain assessment-related GIS information, the Department is evaluating how to best merge these two separate data systems. The Department is working with the Vermont Center for Geographic Information (VCGI) to develop a method by which the waterbody identification codes for both streams and lakes can be transferred to the National Hydrography Dataset (NHD). This data set is still under development for Vermont. VCGI staff are working to generate an NHD for all of Vermont (at a scale of 1:24,000) and have an active pilot project to refine NHD to 1:5,000. Over the course of the next reporting period, the Department's ability to bridge assessment data to the NHD will be clarified, as will progress towards segmenting stream waterbodies.

## Chapter Three: Rivers & Streams Water Quality Assessment

### *Statewide Water Quality Assessment/Designated Use Support*

Vermont's statewide surface water quality has been determined by updating past years' statewide assessment data with water quality information and data from watersheds assessed in the last two years. The tables and narrative below give the overall and individual use support summaries for the state's waters.

According to EPA, Vermont has approximately 7,100 miles of perennial rivers and streams. Of the 5,450 river and stream miles assessed for this report, overall approximately 78% are in compliance with the state's water quality standards and fully support designated uses, and 22% are not in compliance with the water quality standards or do not fully support the designated uses.

Of the 5,450 miles of river or stream assessed for use support, 15% (838 miles) of the assessments are based on in-stream monitoring data and 85% (4612 miles) of the assessments are based on a variety of other information including habitat assessments, conditions such as channelization, combined sewer overflows (CSO), or severe streambank erosion judged to cause impairments or threats, modelling, and non-singular incidences of fish kills or spills.

For this assessment cycle, the Department is also providing the results of a statistically designed estimation of aquatic life use support for all waters statewide. This probabalistic assessment of aquatic life use support used existing data from 301 individual monitoring sites across Vermont, which were subsampled using the spatially randomized selection employed by the US EPA EMAP program.

### *Individual Use Support Summary*

Table III.3.1 below is a summary of the number of miles of rivers and streams throughout Vermont which fully support or do not fully support the water quality standards or designated uses of the waters. For each river use or value that is assessed, the miles of river or stream fully supported, fully supported but threatened, partially supported, or not supported are determined. For example, river miles that are fully supported for aquatic biota have macroinvertebrate and fish communities in good to excellent health based on a number of metrics for each community. River miles that are fully supported for swimming have no known high levels of *E. coli*, a bacteria that is used as an indicator for pathogens. A full description of the assessment methodology is given in Chapter Two. Overall use support, expressed as proportion of miles meeting/not meeting uses, by waterbody, is shown in Figure III.3.1

The number of miles in each support category are provided for seven uses or values: aquatic biota and/or habitat, contact recreation (swimming, tubing), secondary contact recreation (boating, fishing), aesthetics, fish consumption, drinking water supply and agricultural water supply. The use called "overall" reflects the miles for which one or more of the uses are not supported, partially supported, threatened or fully supported. The fish consumption use is not factored into the "overall" category because all miles of river and stream are at least threatened for fish consumption due to a statewide fish consumption advisory. If taken into account in "overall", this status would mask the extent of other threats.

**Table III.3.1. Statewide Overall and Individual Use Support Summary.**
*** Rivers and Streams ***

| Designated Use | Full support (miles) | Full support but threatened (miles) | Partial support (miles) | Non-support (miles) | Total assessed miles |
|---|---|---|---|---|---|
| Overall | 3,184.6 | 1,084.1 | 968.0 | 213.1 | 5,449.8 |
| Aquatic biota/habitat | 3,267.1 | 1,103.6 | 912.1 | 167.0 | 5,449.8 |
| Contact recreation | 4,162.0 | 686.3 | 405.4 | 85.1 | 5,338.8 |
| Secondary contact recreation | 4,329.5 | 447.5 | 495.2 | 97.5 | 5,369.7 |
| Aesthetics | 3,818.3 | 836.8 | 669.1 | 107.9 | 5,432.1 |
| Drinking water supply | 3,262.1 | 197.2 | 69.6 | 32.1 | 3,561.0 |
| Agricultural water supply | 835.0 | 119.9 | 43.7 | 23.2 | 1,021.8 |
| Fish consumption | 0.0 | 5,696.7 | 76.5 | 34.5 | 0.0 |

***Causes and Sources[1] of Impairments, Impacts, and Threats***

A cause is a pollutant or condition that results in a water quality impairment, impact or threat; a source is the origin of the cause and can be a facility, a land use, or an activity. The sources are subdivided into point and nonpoint, and a nonpoint source is defined as any pollutant not discharged directly from the end of a pipe. Tables III.3.2 and III.3.3 summarize the miles of rivers and streams affected by various causes and sources, respectively.

[1] These cause and source categories have been established by the U.S. Environmental Protection Agency.

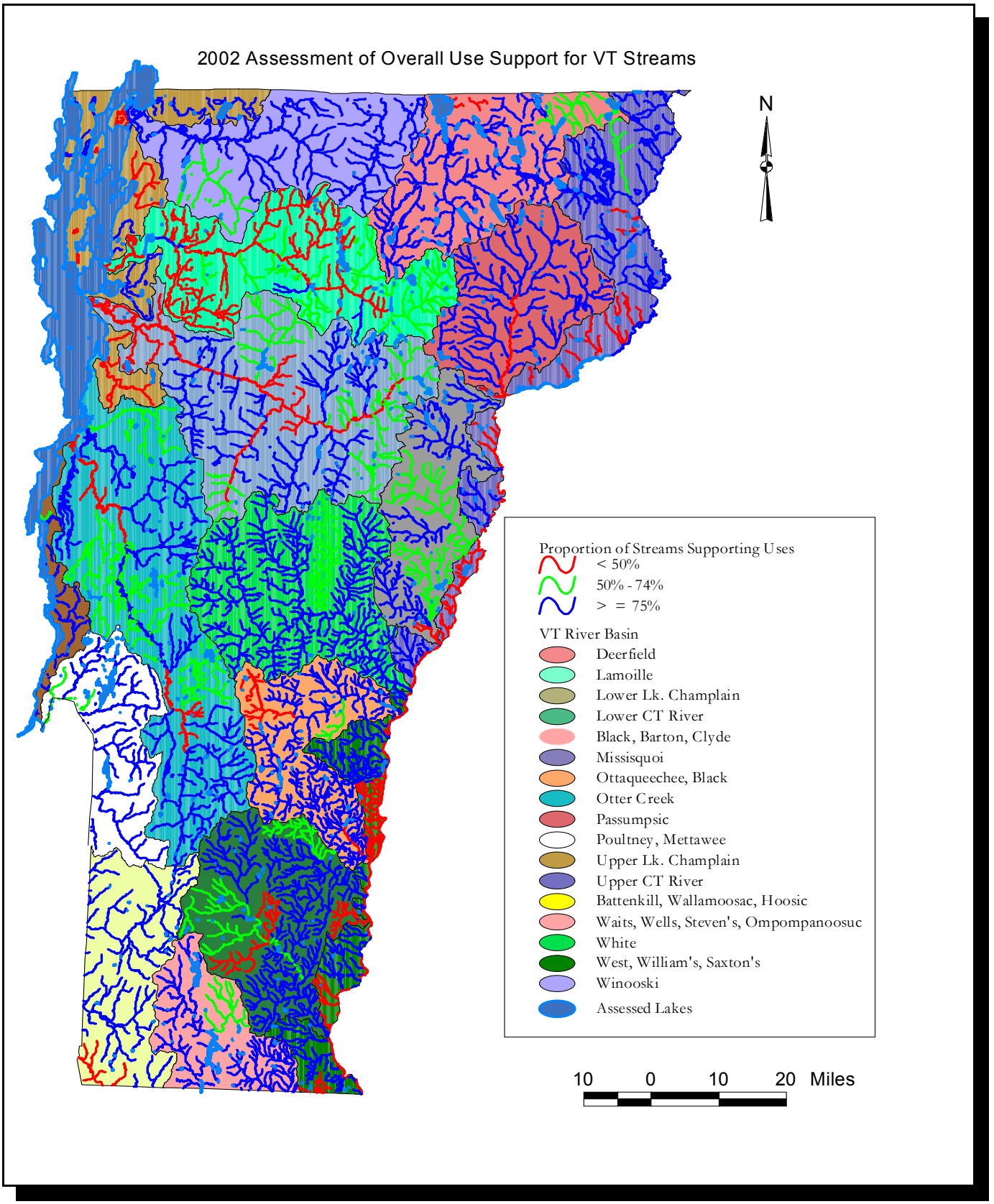


Figure III.3.1

Because a stretch of river or stream may be affected by more than one cause or source, the same mileage may be tallied in several places in Tables 3.2 and 3.3. For this reason, the two columns on each table are not additive because the total would overestimate the total number of miles affected by all causes and sources in Vermont. The purpose of these summaries is to give natural resource managers and the public, in relative terms, an idea of the relative size of impact of different pollutants or conditions on Vermont's waters and from which land uses or activities they may originate.

***Summary of Causes***

Sedimentation/siltation is the largest cause of impacts and impairments to river or stream water quality or aquatic habitat in Vermont. Sedimentation/siltation has long been the leading pollutant of our flowing waters. Unnatural levels of sediment alter or destroy macroinvertebrate habitat and fish spawning areas, fill in swimming holes, and cause the river or stream channel to become unstable. Sedimentation affects about 860 miles of river and stream and threatens another 983 miles based on the information available at this time.

The second largest documented cause of impacts and impairments is thermal modification or water temperature increases. This problem affects about 472 miles and threatens another 324 miles. A close third in terms of pollutants or conditions is nutrient loading to waters. Nutrients affect 451 miles of river and stream and threaten another 486 miles.

The other substantial causes identified include: flow alterations affecting 358 miles and threatening another 124 miles; physical habitat alterations affecting 340 miles and threatening 188 miles; pathogens affecting 335 miles and threatening 512 miles; organic enrichment/low dissolved oxygen affecting 328 miles and threatening 222 miles; metals affecting 238 miles and threatening another 139 miles; and turbidity affecting 234 miles and threatening 119 miles.

Past assessments have generally had similar results in terms of which pollutants or conditions have the most impact on water quality or aquatic habitat. Sedimentation was the most extensive cause of pollution in the 2000, 1998 and 1996 305b assessments. The next six causes following sedimentation have been thermal modifications, nutrients, flow alteration, physical habitat alteration, pathogens, and organic enrichment/low dissolved oxygen in at least the last three assessments although not in the same order each assessment year.

**Table III.3.2. Total River and Stream Miles with Impairments, Impacts, or Threats by Cause Category.**

| Cause of impairment | Magnitude of impairment (miles) | | Total miles impaired by cause | Miles threatened by cause |
|---|---|---|---|---|
| | High | Moderate | | |
| Sedimentation | 382.6 | 477.0 | 859.6 | 983.2 |
| Thermal modifications | 142.6 | 329.1 | 471.7 | 324.1 |
| Nutrients | 148.6 | 302.7 | 451.3 | 485.6 |
| Flow alterations | 186.7 | 178.4 | 365.1 | 124.1 |
| Physical habitat alterations | 177.3 | 162.2 | 339.5 | 187.9 |
| Pathogens | 95.9 | 238.9 | 334.8 | 512.1 |
| Organic enrichment/low D.O. | 88.3 | 239.9 | 328.2 | 221.9 |
| Metals | 191.5 | 46.5 | 238.0 | 138.8 |
| Turbidity | 4.2 | 229.5 | 233.7 | 119.0 |

***Summary of Sources***

Streambank erosion, as in past assessments, ranks first among all the pollution sources with 603 miles of impact and 409 miles of threats from this problem. Streambank erosion is described as a source in and of itself, but this 'source' results from other 'sources' such as riparian vegetation removal and channel instability. Streambank erosion is the primary source of the sediments that are the top cause of water quality and aquatic habitat impacts.

Agricultural land uses and activities affect the second greatest number of river miles with 528 miles of impact and 560 miles threatened. Agricultural activities can result in nutrient, pathogen and/or sediment runoff from pasture land, crop production and animal management areas and can also result in loss of riparian vegetation.

Removal of riparian (streamside) vegetation is the third highest source of impact or impairment to Vermont's rivers and streams, with 422 miles affected by this activity and 318 miles threatened. Removal of riparian vegetation continues to be a growing problem in the state. Individual residential and commercial landowners, farmers, town road crews and the Agency of Transportation all encroach on the riparian zone with their activities and the result is the loss of the trees and shrubs protecting rivers and riverbanks. Flooding and channel instability also result in loss of riparian vegetation. Riparian vegetation removal results in sedimentation and thermal modification, the two largest causes of river and stream impacts.

The fourth and fifth highest sources of pollution are flow modification and upstream impoundment, respectively. Flow regulation below hydroelectric power and flood control dams causes low and fluctuating flows or dewatering of channels; snowmaking and water supply withdrawals also alter

natural flows. Reduced or fluctuating flows affects the amount of aquatic habitat available downstream as well as dissolved oxygen levels, temperature and other water quality parameters. Flow regulation has an impact on 392 miles and threatens another 64 miles.

Upstream impoundments are bodies of water behind hydroelectric or other dams. Impoundments cause warming of the water, streambank erosion, act as sediment traps, and change fish and wildlife habitats from quick-moving water to still or slow-moving water. Upstream impoundments impair 296 miles of streams and rivers and threaten another18 miles.

The sixth highest source of surface water pollution is land development. Land development includes clearing, grading, excavation and filling, done in many cases with no or improperly maintained erosion control devices. Runoff from land development caused 228 miles of impact or impairment and threatens another 394 miles.

Atmospheric deposition, the seventh highest source, is primarily responsible for mercury and acidified conditions in Vermont's surface waters. While these conditions are most exacerbated in lake systems, stream biological communities do exhibit quantifiable impacts, particularly due to acidification. The extent to which river and stream systems are impacted by mercury (also expressed as Hg) is ill-studied in Vermont with the exception of the Deerfield River watershed area. In this well-studied area, where fish tissue mercury concentrations are high, the cause is presumably due to enhanced methylation of Hg at the de-watered littoral interface of the five reservoirs and can be coupled with some of the highest mercury wet-deposition rates in the State. Deposition of mercury and acid precipitation results from a mix of out-of-state and regional sources. The emissions of mercury from Vermont to its' airshed have recently been found to be minimal. Emissions of acid-forming presursors such as SO4 and NOx are limited relative to neighboring States and nationally. These difficult problems are being addressed at several levels and in a variety of ways, at regional and national scales. This is discussed further in Part II, Chapter 5.

Road and bridge runoff is the eighth largest source of impact affecting 167 miles and threatening another 302 miles with the information available to date. Most of the road/bridge water quality impairments come from gravel town roads that drain toward streams and discharge silt to them. Runoff from bridges over streams goes directly into streams. Road runoff also goes to slopes adjacent to the bridge abutments, which causes the slopes to erode to the streams. In addition, highway maintenance often includes washing pollutants off bridges into adjacent rivers and streams.

The ninth highest source, onsite wastewater systems, as listed in the "Source" table are failed septic systems which may directly or indirectly discharge to nearby streams. The 134 stream miles affected by this source is a concern from a human health viewpoint.

The tenth highest source of water quality impairment is developed land runoff, which has affected 131 miles of rivers and streams. This category includes runoff from any urban, suburban, village or other developed areas. Developed land changes the amount and timing of runoff reaching rivers and streams and the runoff contains many pollutants including sediment, metals, nutrients and organic compounds.

**Table III.3.3. Total Miles of Rivers and Streams with Impairments, Impacts or Threats by Source Category.**

| Source of impairment | Magnitude of impairment (miles) | | Total miles impaired by source | Miles threatened by source |
|---|---|---|---|---|
| | High | Moderate | | |
| Agriculture | 206.4 | 321.2 | 527.6 | 560.5 |
| Riparian vegetation removal | 116.1 | 306.4 | 422.5 | 318.3 |
| Flow modification | 190.7 | 208.6 | 399.3 | 63.9 |
| Upstream impoundment | 75.6 | 194.0 | 269.6 | 18.5 |
| Land development | 133.1 | 95.0 | 228.1 | 394.2 |
| Atmospheric deposition | 173.7 | 2.0 | 175.7 | 75.1 |
| Road/bridge runoff | 2.5 | 164.8 | 167.3 | 302.1 |
| Onsite septic systems | 3.7 | 130.5 | 134.2 | 82.1 |
| Developed land runoff | 80.6 | 50.2 | 130.2 | 125.9 |
| Channel instability | 63.9 | 46.5 | 110.4 | 11.9 |
| Municipal point sources | 17.4 | 91.6 | 109.0 | 102.5 |
| Floods | 26.8 | 80.2 | 107.0 | 21.4 |

***Probabilistic Statewide Assessment of Aquatic Life Use Support***

During the reporting period, the Department worked collaboratively with investigators at US EPA's National Health and Environmental Effects Laboratory, Western Ecology Division, to assess the proportion of *all* Vermont wadeable streams meeting aquatic life uses. Existing and available macroinvertebrate (301 sites) and fish (153 sites) monitoring data from the Ambient Biomonitoring Network (ABN) were used in conjunction with spatially randomized techniques for sample site selection, to derive a statistically unbiased overall assessment of aquatic life use. These unbiased estimates were then compared to results from assessments which were made directly using findings from the non-randomized Vermont biological database. This represent the first statistically-derived, unbiased estimate of overall aquatic life use support for all wadeable Vermont streams.

For the unbiased statewide estimation, aquatic life use support was assessed using macroinvertebrate data from 50, 100, 200, and 301 sites, and fish from 50, 100 and 153 sites. In all cases, the proportion of sites exhibiting excellent or good biotic integrity was unaffected by assessment intensities (number of sites included in the subsample). The proportion of sites identified as fair increased with increasing intensity. In relation to the non-randomized findings, the subsampling-based estimates consistently identified a greater proportion of sites as exhibiting 'excellent' or 'good' biotic integrity, and a lower proportion of sites exhibiting poor integrity, indicating that a bias towards assessing potentially degraded streams is inherent in the design of the ABN. Figure III.3.2 shows the geographic distribution of ABN sites as well as that of the probability-based sampling locations for the macroinvertebrate-based assessment made with 100 randomly-subsampled sites. Figure III.3.3 compares results of the random and ABN macroinvertebrate assessments for the same 100 sites. Figure III.3.4 compares results of the random and ABN fish assessments at a 50 site assessment intensity level.

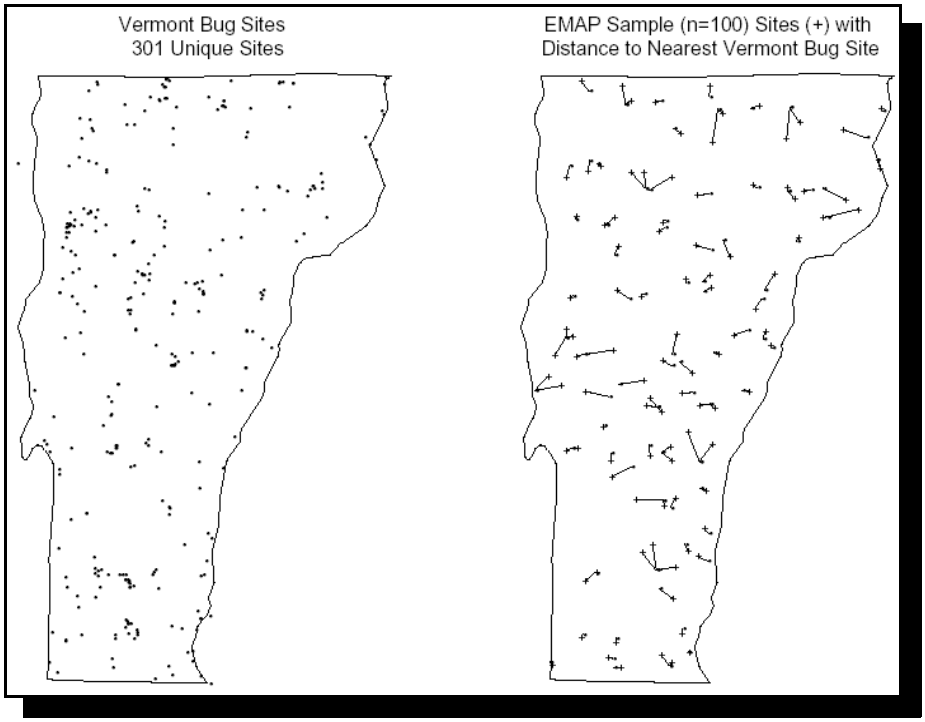


Figure III.3.2. Approximate locations of ABN macroinvertebrate sites (left) and distribution of 100 randomly-selected locations with distance to the ABN location used to represent the randomly selected site (right).

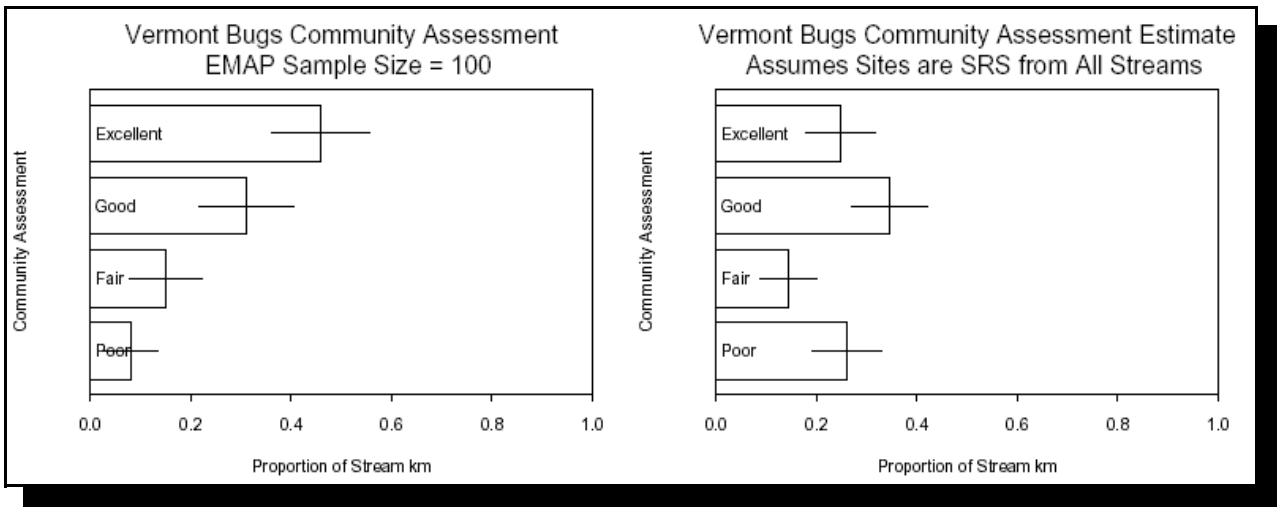


Figure III.3.3. Potentially unbiased (left) and biased (right) assessment of macroinvertebrate biological integrity for wadeable Vermont streams. Error bars are 95% confidence intervals. The 'biased' assessment includes data from 301 sites within the ABN database.

The probability-based assessment approach identifies a greater proportion of sites attaining aquatic life uses. This is because, outside of reference characterization efforts, ABN sampling most commonly involves sites of either known or suspected impairment. This is shown in Figure III.3.2 (left image) by the geographic 'clustering' of sample locations. The approach used here of subsampling a well-populated database using a randomized design permits reporting of potentially unbiased estimates of use attainment, without needing to design and execute additional costly studies. The presumption that the random site selection minimizes the bias of the underlying assessment is rebuttable since some circularity is inherent in this assessment approach. This is because the random sites are not independent of the ABN sites. Project collaborators concede that mathematically describing the degree to which bias has been reduced using the subsampling approach is not feasible. The

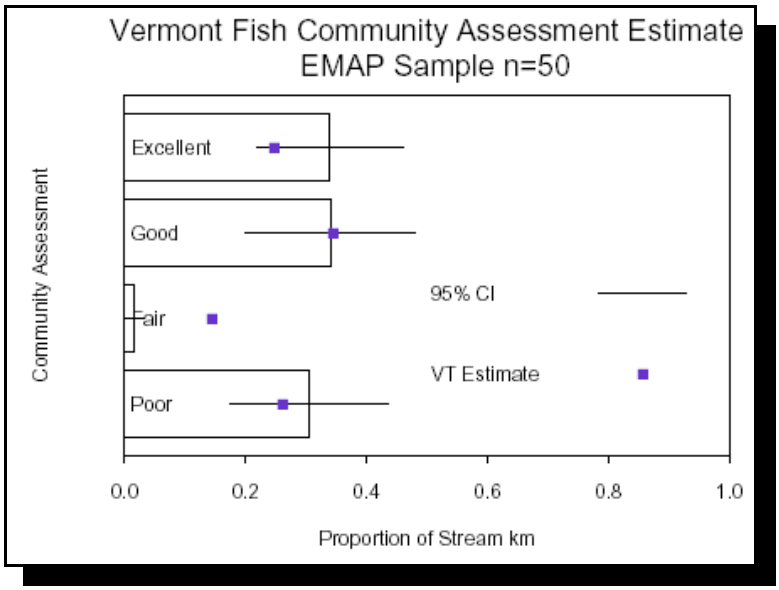


Figure III.3.4. Unbiased (bars) and biased (points) assessment of fish biological integrity for wadeable Vermont streams. The 'biased' assessment includes data from 153 sites within the ABN database. Confidence bounds relate to the 'unbiased' estimates.

Department believes, however, that the process eliminates some sources of bias in the assessment data base, by selecting sampling locations in proportion to the density of waters in a given geographic region, and thus provides a result that approaches the "true condition." This approach shows potential for reporting overall attainment for a variety of uses, for areas where developed fixed-station monitoring networks in place (and thus where initiating truly randomized probability-based field assessments in undesirable). VDEC intends to conduct further evaluations of the potential of this method to provide a realistic and defensible statewide assessment of aquatic life use support status. The Department is also evaluating the feasibility of using other databases such as those describing fish tissue contaminants and lakes trophic status, to subsample and subsequently report statewide use support.

## Chapter Four: Lakes and Ponds Water Quality Assessment

This chapter reports on overall use support, and on the causes and sources of stressors which engender non-support of uses, for inland Vermont lakes. The reader will note reasonably significant changes in the values presented in this 2002 305b report relative to prior reports. The reasons for these changes are largely related to comprehensive reassessments which have been performed on approximately one quarter of the 558 lake waterbodies in the assessment database since the issuance of the 2000 report.

Vermont's lake assessment database remains in a period of flux. As waters are revisited and the assessments re-evaluated and revised, many of the older observations which were previously used to make a determination of "not fully supporting" have been subjected to rigorous comparisons with available modern and historical data. For example, many waters were previously identified as partially or not supporting uses solely on the basis of observations such as "algae in the water column," or "sediment on the bottom." In those instances where the observations were not validated with data indicating a deviation from the Vermont Water Quality Standards, or by a record of public complaints regarding the condition (which would suggest a loss of a designated use), the partial or non support acreage was converted to full support, or fully supported but threatened. Since the Department is three-quarters through the comprehensive 5-year rotating reassessment period, the following tables capture simultaneously revised, corrected assessments, and older, to-be-revised assessments.

It is the intent of the Department to perform all revisions to the 11 Lake Champlain waterbody segment entries in the database at the completion of the 5-year rotating assessment cycle. Accordingly, for an assessment of use support, causes, and sources for Lake Champlain, the reader is referred to Vermont's 1996 305b Report.

This chapter is formatted such that uses, causes, and sources are presented individually, and are only cursorily related to each other. The major threats and stressors to inland Vermont lakes are then highlighted.

### *Assessment of Use Support for Inland Vermont Lakes:*

Individual use support for inland lakes and ponds is highlighted in Table III.4.1 and Figure III.4.1. There are 55,477 assessed inland lake acres in Vermont. This represents an increase of 1,869 acres, which are due to the addition of two large reservoirs (Moore and Comerford located in Concord and Waterford) to the Lake Assessment Database. Overall, 32,117 lake and pond acres (58% of the total) fully support all uses. Of these acres, 59% are presently considered to have overall uses threatened. Aesthetics are supported on 48,190 acres (87%), and this use is considered threatened on 22% of these acres. Aquatic life uses are supported on 37,292 acres (67%), and this use is considered threatened on 42 % of the supported acres. Fish consumption uses are supported on only 40,732 acres (83%), which is a direct manifestation of the existing Vermont Department of Health advisory against consumption of freshwater fish due to mercury contamination, and reflects those waters where the Department considers fish consumption uses truly impaired (see Chapter 2, above, for methodological considerations). Secondary contact and swimming uses are supported on 42,693 (74%), and 47,907 (84%) acres, respectively, with 20% of these acres threatened in both cases.

Agricultural, industrial, filtered, and drinking water supply uses are unassessed for the majority of Vermont lake acres. A comparison of these values to those reported in 2000 suggest a significant improvement in overall use support for Vermont lakes. This simultaneously reflects water quality improvements, as well as the comprehensive reassessments using new and robust methods.

**Table III.4.1. Statewide Use Support.**
***547 Inland Vermont Lakes and Ponds***

| Use | Acres Fully Supporting Uses | Acres with Uses Threatened | Acres Partially Supporting Uses | Acres Not Supporting Uses | Acres Not Assessed |
|---|---|---|---|---|---|
| Overall Uses | 13,160 | 18,957 | 19,541 | 3,662 | 157 |
| Aesthetics | 37,469 | 10,721 | 3,923 | 3,193 | 171 |
| Aquatic Life Use Support | 21,447 | 15,845 | 15,803 | 2,225 | 157 |
| Agricultural Water Supply | 0 | 0 | 0 | 0 | 53,465 |
| Drinking Water Supply | 1,268 | 0 | 123 | 0 | 123 |
| Fish Consumption | 40,732 | 6,152 | 7,835 | 0 | 758 |
| Filtered Water Supply | 1,289 | 0 | 123 | 0 | 52,053 |
| Industrial Water Supply | 0 | 0 | 0 | 0 | 53,465 |
| Secondary Contact Uses | 34,037 | 8,656 | 7,999 | 3,208 | 1,577 |
| Swimming Uses | 38,281 | 9,626 | 2,785 | 3,208 | 1,577 |

***Assessment of Causes of Use Support Impairment for Inland Vermont Lakes***
There are 18 general causes of use impairments for Vermont lakes. These are listed in Table III.4.2. When referring to Table III.4.2, the reader should be aware that, in many cases, several of these causes simultaneously impact uses on a single lake. Thus, the acreages impacted by these causes cannot be summed to arrive at an estimate of the entire acreage impacted statewide for all causes. Causes are arrayed in order of decreasing total impaired acreage.

Ten separate cause categories impact uses on at least 1,000 lake acres. The most widespread of these is metals; most specifically mercury. A related cause is low pH, which is the third largest cause of impact to Vermont lakes. Flow alteration is the second largest cause of impact to Vermont lakes. Causes related to eutrophication (nutrients, algae, siltation, and organic enrichment) constitute the fourth through seventh largest causes, respectively. While the acreage impacted by exotic species is low relative to some of the above mentioned causes (1,383 acres), the importance of exotic species as the cause of serious degradation to Vermont lakes cannot be underestimated (refer to Part II under State Concerns and Recommendations).

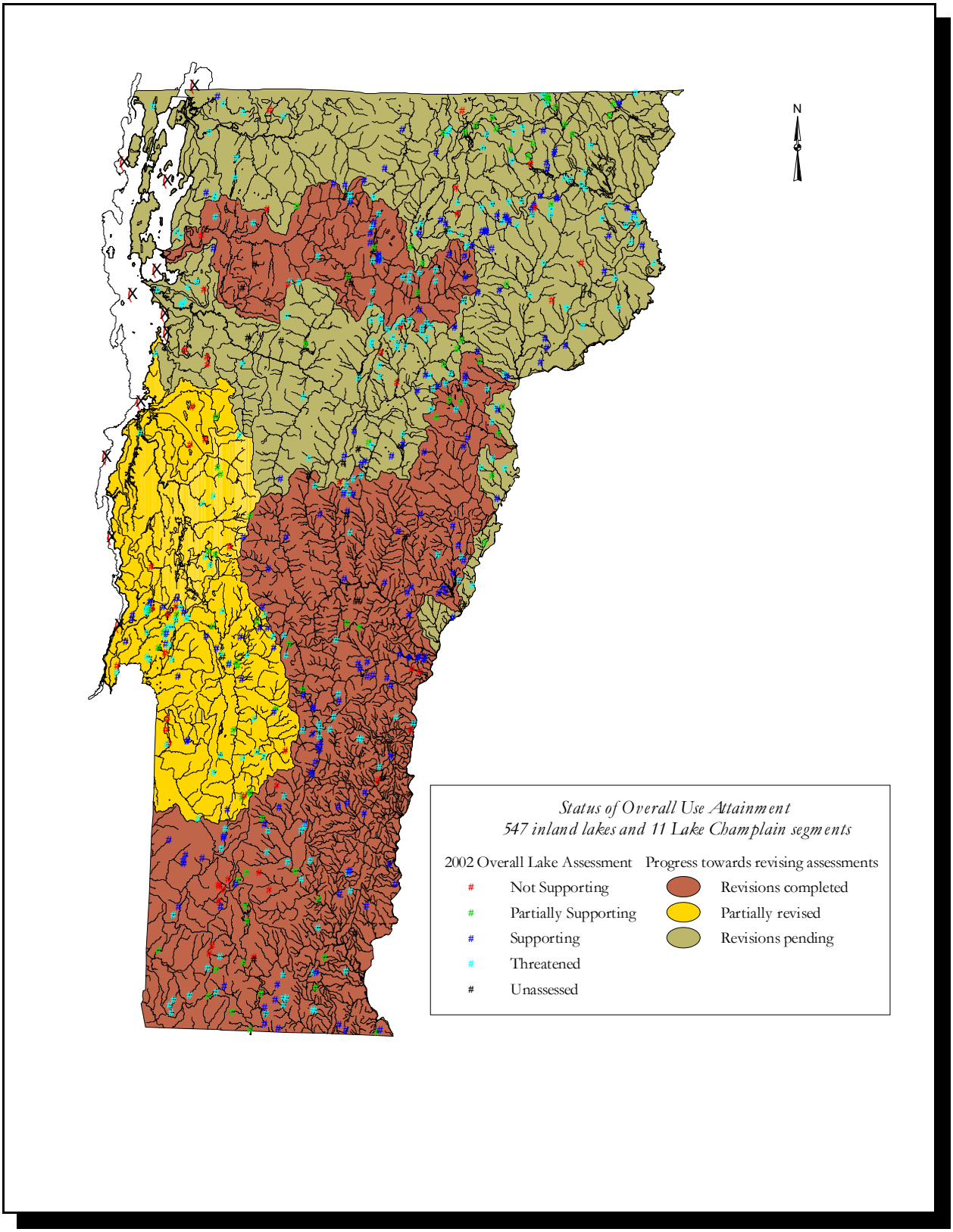


Figure III.4.1. Overall use support for assessed lakes and ponds in Vermont. Progress towards complete reassessment, by major river basin, is also shown.

**Table III.4.2. Total Size of Waters Impaired of Threatened by Causes of Impacts (in Acres).**
*** 547 Inland Vermont Lakes and Ponds ***

| Cause of impact | Magnitude of impact | | | Total acres impaired by cause | Acres threatened by cause |
|---|---|---|---|---|---|
| | High | Moderate | Low | | |
| 1500 Flow alteration | 4,240 | 4,960 | 0 | 9,200 | 2,315 |
| 0500 Metals | 6,311 | 760 | 0 | 7,071 | 6,152 |
| 0560 Mercury | 6,311 | 760 | 0 | 7,071 | 6,152 |
| 1000 pH | 711 | 3,692 | 0 | 4,403 | 6,790 |
| 0900 Nutrients | 3,421 | 565 | 59 | 4,045 | 4,937 |
| 0910 Phosphorus | 3,421 | 565 | 59 | 4,045 | 4,962 |
| 2210 Noxious aquatic plants - Algae | 1,597 | 1,552 | 0 | 3,149 | 2,789 |
| 1100 Siltation | 1,151 | 1,032 | 583 | 2,766 | 3,165 |
| 1200 Organic enrichment - DO | 1,866 | 30 | 0 | 1,896 | 690 |
| 2600 Exotic Species | 1,344 | 149 | 0 | 1,493 | 5,156 |
| 2200 Noxious aquatic plants - Native | 424 | 338 | 477 | 1,239 | 838 |
| 0000 Cause unknown | 26 | 0 | 0 | 26 | 0 |
| 1700 Pathogens | 13 | 0 | 0 | 13 | 828 |
| 0800 Other inorganics | 6 | 0 | 0 | 6 | 0 |
| 2400 Total Toxics | 1 | 0 | 0 | 1 | 0 |
| 1300 Salinity - TDS - chlorides | 0 | 0 | 0 | 0 | 9 |
| 2300 Filling and Draining | 0 | 0 | 0 | 0 | 49 |
| 2500 Turbidity | 0 | 0 | 0 | 0 | 51 |

With the exception of metals and mercury, the same causes listed above also constitute the major threats to uses on Vermont lakes. While pH impacts uses on 4,403 acres, it represents the single greatest threat to uses on 6,790 lake acres. An even more striking example is that of exotic species, which impact 1,493 acres but threaten 5,156 acres. Other major threats, in order of magnitude, include: nutrients; siltation; algae; and organic enrichment. The relative importance of native aquatic plants as a cause of both impact and threat to uses in Vermont lakes should be treated cautiously. In the process of performing the reassessments completed to date, impacts related to native aquatic macrophytes were one of the most commonly modified entries, with most of the impacts being changed to threats. Since approximately one quarter of the inland lake waterbodies have yet to be reassessed, Table III.4.2 overestimates the extent of impairments due to native aquatic plants.

***Assessment of Sources of Use Support Impairment for Inland Vermont Lakes***

There are several general sources of use impairments for Vermont lakes (Table III.4.3). When referring to Table III.4.3, the reader should be aware that the acreages impacted by these sources cannot be summed to arrive at an estimate of the entire acreage impacted statewide. In many cases, several of these sources simultaneously impact uses on a single lake. Sources are arrayed in order of decreasing total impaired acreage.

Of the 42 separate sources of impacts on uses, eight major sources account for impact to at least 1,000 acres. The single most important source, impacting 11,224 lake acres, is hydromodification including flow alteration. Acidic deposition is the second most important. Natural sources, which relate to acidification, are the third most important. Agriculture (4th), general nonpoint sources (5th), and land disposal (8th), are all related to eutrophication. Finally, in-water releases of exotics due to boating traffic constitutes the seventh most important source.

**Table III.4.3. Total Size of Waters Impaired or Threatened by Various Sources (in Acres).**

*** 547 Inland Vermont Lakes and Ponds ***

| Source of impact | Magnitude of impact | | | Total acres impaired by source | Acres threatened by source |
|---|---|---|---|---|---|
| | High | Moderate | Low | | |
| 7400 Flow Regulation/Modification | 4,252 | 6,972 | 0 | 11,224 | 2,444 |
| 7000 HYDROMODIFICATION | 4,256 | 4,960 | 0 | 9,216 | 2,426 |
| 8100 ATMOSPHERIC DEPOSITION | 7,205 | 791 | 1,212 | 9,208 | 11,294 |
| 8600 NATURAL SOURCES | 111 | 4,154 | 550 | 4,815 | 7,329 |
| 1000 AGRICULTURE | 3,195 | 586 | 0 | 3,781 | 1,355 |
| 9070 VT-UNSPECIFIED NONPOINT SOURCE | 2,718 | 79 | 52 | 2,849 | 468 |
| 1100 Nonirrigated Crop Production | 2,288 | 518 | 0 | 2,806 | 615 |
| 1400 Pasture Grazing-Riparian and/or Upland | 1,650 | 679 | 0 | 2,329 | 879 |
| 1800 VT-Animal holding/management area | 2,115 | 91 | 0 | 2,206 | 555 |
| 7900 MARINAS AND RECREATIONAL BOATING | 1,366 | 189 | 0 | 1,555 | 5,207 |
| 7910 In-Water releases | 1,366 | 189 | 0 | 1,555 | 5,130 |
| 7550 HABITAT MODIFICATION (OTHER THAN HYDROMOD) | 871 | 356 | 2 | 1,229 | 37 |
| 6000 LAND DISPOSAL | 452 | 0 | 694 | 1,146 | 825 |
| 7700 Streambank Modification/Destabilization | 871 | 135 | 1 | 1,007 | 100 |
| 6500 Onsite Wastewater Systems (Septic Tanks) | 0 | 0 | 694 | 694 | 154 |
| 3000 CONSTRUCTION | 256 | 421 | 16 | 693 | 3,695 |
| 3200 Land Development | 256 | 421 | 12 | 689 | 3,695 |
| 8300 HIGHWAY MAINTENANCE AND RUNOFF | 294 | 74 | 173 | 541 | 3,746 |
| 0200 MUNICIPAL POINT SOURCES | 0 | 521 | 0 | 521 | 0 |
| 0400 COMBINED SEWER OVERFLOW | 0 | 470 | 0 | 470 | 0 |
| 6400 Industrial Land Treatment | 452 | 0 | 0 | 452 | 446 |
| 7600 Removal of Riparian Vegetation | 0 | 306 | 1 | 307 | 1,109 |
| 1500 Range Grazing-Riparian and/or | 0 | 173 | 0 | 173 | 0 |

| Source of impact | Magnitude of impact | | | Total acres impaired by source | Acres threatened by source |
|---|---|---|---|---|---|
| | High | Moderate | Low | | |
| Upland | | | | | |
| 8950 Other | 0 | 100 | 0 | 100 | 0 |
| 9000 SOURCE UNKNOWN | 27 | 58 | 0 | 85 | 1,099 |
| 2000 SILVICULTURE | 66 | 10 | 0 | 76 | 2,195 |
| 2100 Harvesting, Restoration, Residue Management | 61 | 0 | 0 | 61 | 1,900 |
| 8530 INTERNAL NUTRIENT CYCLING (LAKES) | 54 | 0 | 0 | 54 | 72 |
| 0100 INDUSTRIAL POINT SOURCES | 6 | 0 | 0 | 6 | 11 |
| 4000 URBAN RUNOFF/STORM SEWERS | 1 | 3 | 0 | 4 | 1,147 |
| 5000 RESOURCE EXTRACTION | 1 | 0 | 0 | 1 | 21 |
| 5100 Surface Mining | 1 | 0 | 0 | 1 | 21 |
| 1200 Irrigated Crop Production | 0 | 0 | 0 | 0 | 20 |
| 1410 Pasture Grazing-Riparian | 0 | 0 | 0 | 0 | 11 |
| 2300 Logging Road Construction/Maintenance | 0 | 0 | 0 | 0 | 20 |
| 3100 Highway/Road/Bridge Construction | 0 | 0 | 0 | 0 | 4 |
| 4300 Other Urban Runoff | 0 | 0 | 0 | 0 | 163 |
| 4500 Highway/Road Bridge Runoff | 0 | 0 | 0 | 0 | 135 |
| 4600 Erosion and Sedimentation | 0 | 0 | 0 | 0 | 3 |
| 6300 Landfills | 0 | 0 | 0 | 0 | 14 |
| 7300 Dam Construction | 0 | 0 | 0 | 0 | 37 |
| 8520 DEBRIS AND BOTTOM DEPOSITS | 0 | 0 | 0 | 0 | 20 |
| 8700 RECREATIONAL AND TOURISM ACTIVITIES (NOT BOATING) | 0 | 0 | 0 | 0 | 105 |

With respect to sources that result in threats to uses of Vermont lakes, the roster is similar. Ten major sources comprise threats to at least 1,000 acres statewide. Natural sources and atmospheric deposition are the most important sources of threats. While boating and associated in-water releases are the source of impacts to 1,555 acres, about 5,207 acres are threatened by this exotic species spread vector. Highway (and other roadway) maintenance ($4^{th}$), construction ($5^{th}$), silviculture ($7^{th}$), agriculture ($8^{th}$) and urban runoff ($7^{th}$), are all sources of threats related to eutrophication. Finally, hydromodification ($6^{th}$) threatens uses on 2,423 acres.

Based on the use support, cause and source information presented above, the following issues surface as the most important ones presently affecting inland Vermont lakes: *Atmospheric Deposition of Pollutants, Hydrologic Modifications, Exotic Aquatic Species as Pollutants*, and *Eutrophication of Vermont Lakes.* For a discussion of these issues, please refer to Part II, Special State Concerns and Recommendations. Table III.4.4 summarizes the trophic status for inland Vermont lakes. The vast

majority of lakes assessed for trophic status are mesotrophic, although numerous oligotrophic and eutrophic lakes also exist in Vermont.

**Table III.4.4. Trophic Status of Significant Inland Lakes.**

| Trophic State | Number of individual lakes | Total acres in category |
|---|---|---|
| Unclassified | 334 | 12,638 |
| Dystrophic | 21 | 587 |
| Eutrophic | 30 | 6,252 |
| Hypereutrophic | 2 | 473 |
| Mesotrophic | 125 | 25,549 |
| Oligotrophic | 35 | 9,978 |
| Total | 547 | 55,477 |

## Chapter Five: Basin Assessments Completed During the 2002 305b Reporting Period

During the 2002 305b reporting period, VDEC was able to complete its assessment of two river basins (Basin 7 and Basin 11). Also during the period, an assessment for a portion of Basin 16 was completed. Assessment findings for each of these areas are provided below. For greater detail on the findings of these assessment efforts, the reader is referred to Appendix D.

*Summary for Basin 7 - Lamoille River Basin*

Of the 611 miles of rivers and streams identified to date in the Lamoille River watershed, 35% of the miles (216) fully support aquatic biota and habitat with no threats identified, 4% (27 miles) fully support this use but threats are known and 28% (172 miles) do not fully support aquatic biota/habitat. Approximately 32% of the miles in the basin (197) were not assessed. Sediment and habitat alterations are the major causes of the habitat problems. Loss of riparian vegetation, streambank erosion, and channel instability result in the sediment and physical alterations that affect aquatic habitat through much of the Lamoille River watershed.

Riparian vegetation removal, streambank erosion, floodplain encroachments, floods, and agricultural land uses are the five top sources that affect the water quality and aquatic habitat of the Lamoille River. Agricultural land use in the productive floodplain of the Lamoille resulted in some riparian vegetation removal. The lack of vegetation along, and back from, the riverbank is often a major contributing factor to streambank erosion and channel instability. The habitat alteration and flood damage was greatly exacerbated by the unstable condition of the river and the lack of riparian vegetation along the Lamoille and some of its tributaries such as the Wild Branch. The dams and impoundments for hydro-electric production on the Lamoille River also alter the river's condition by degrading water quality, substrate composition and thermal regime from flow fluctuations, drawdowns and desilting.

*Summary for Basin 11 - West, Williams & Saxtons Rivers Basin*

There are approximately 432 miles of rivers and streams in Basin 11, all of which were assessed. Of these miles, 54% of the miles (235) fully support aquatic biota and habitat with no threats identified, 19% (83 miles) fully support this use but threats are known and 26% (114 miles) do not fully support aquatic biota/habitat.

The cause of most river miles with impacts is thermal modification or water temperatures that are too high to fully support a coldwater fishery. Removal of the riparian trees and shrubs, which is the source affecting the most river miles, results in these higher temperatures. Dams and the resulting impoundment of water also results in higher downstream water temperatures. Much of the Williams River and West River as well as the lower half of the Saxtons River have high temperatures in the summer, which have an impact on the coldwater fishery.

Physical habitat alterations are a result of flow regulation, channelization/instream modification, road and bridge work, and channel instability. Other pollutants or conditions affecting the rivers or streams in this basin include flow alteration primarily from the two Army Corps of Engineers flood control dams, nutrients primarily from agricultural land activities, low pH as a result of acid rain and pathogens possibly from failed septic systems.

*Summary for Basin 16 (partial) - Nulhegan River, Paul & Wheeler Streams*
During 1998, the State of Vermont and the US Fish and Wildlife Service acquired a vast tract of land in northeastern Vermont from the Champion International Corporation. At that time, little biological survey information existed from the several ponds and numerous rivers and streams in these newly-acquired areas. In order to assist with the development of management plans affecting this vast tract of land, a biological survey of fish and macroinvertebrates was conducted in lakes and rivers within a 48,000 acre area. The following paragraphs summarize the survey's findings.

**Nulhegan River**
The streams that were sampled in the Nulhegan River watershed during the summer 2000 were fairly dilute with specific conductances ranging from 14-60 Fmhos. The total variation in pH among the sites sampled was 5.45-7.68. The three sites on the Yellow Branch of the Nulhegan River had the lowest pH values and alkalinities (pH 5.45-5.83, and alkalinity 2- 4.5mg/l ). These values represent summer flows and likely are considerably lower during spring snow melt events, which often bring the highest acidities of the year. As a result, the pH values and alkalinity in the Yellow Branch will be limiting to sensitive fish and macroinvertebrate taxa especially in the orders Ephemeroptera, Bivalvia, and Gastropoda. Other stream reaches that also had low alkalinity and therefore probably undergo a period of low pH in the spring are: Tuffield-Willey and Bluff Mountain Brooks. The low pH and alkalinity of these two streams indicates that other, very high elevation (greater in elevation than 600m ) streams with small watersheds, most likely undergo a period of very low pH and alkalinity.

Fish Assemblages
Twelve sites from eight streams and rivers were sampled within the Silvio Conte lands of the Nulhegan drainage. A total of 450 fish from 16 species were collected. Vermont Department of Fish & Wildlife collected an additional two species and a total of 31 Atlantic salmon, two brook trout, one brown trout and one rainbow trout on the Nulhegan (river mile 1.8) in 2000. The 18 species collected during this survey can be compared to the 30 species actually collected historically from Vermont waters of the Connecticut River drainage.

Index of Biologic Integrity (IBI) values could be generated from only three of 12 sites in the Silvio Conte Refuge. The three sites scored 36 (rating of "very good"), 39 ("excellent") and 9 ("poor"). Five of the sites were classified as low gradient and, consequently, no IBI has been developed as yet for this assemblage type. Two sites supported only brook trout and consequently did not provide enough information to calculate an IBI. Three sites were qualitatively sampled and did not provide data of suitable quality to calculate an IBI. The "poor" evaluation given the Yellow Branch-Nulhegan site (river mile 7.6) may have been due to natural limitations of that river reach. Further assessment in this area may be warranted.

Macroinvertebrate Assemblages
A total of 223 taxa were identified from the 17 stream sites sampled within the Silvio Conte lands of the Nulhegan River watershed. Aquatic insects were the dominant macroinvertebrate class with 195 taxa, broken down by insect order as follows: 81 Diptera (58 Chironomidae), 44 Trichoptera, 19 Coleoptera, 18 Ephemeroptera, 17 Plecoptera, 9 Odonata, 2 Megaloptera and 4 Hemiptera. The remaining taxa were

mainly from the class Mollusca, Gastropoda (eight), and Bivalvia (six). These findings by no means should be considered even close to a complete taxa list of the macroinvertebrate species from running waters within the Silvio Conte lands of the Nulhegan River watershed.

The macroinvertebrate assemblage integrity was evaluated from 12 of the 17 stream reaches sampled for macroinvertebrates. The stream reaches from the Silvio Conte National Refuge were assigned into an assemblage type based on stream size, elevation and alkalinity. Nine of the reaches were evaluated under the Small High Gradient category and three the Medium High Gradient category. The remaining reaches were considered low gradient meandering streams that could not be quantitatively assessed using VDEC protocols. Eight of the 12 stream reaches were rated as either very good or excellent. These streams would be considered very near reference condition compared to other streams from a similar category in Vermont. The four other streams were rated good condition; moderately altered from the natural condition, but still considered to be meeting their Class B water quality management designation.

**Paul & Wheeler Streams**

The data indicate the waters of these drainages are somewhat soft with specific conductances ranging from 26-41 Fmhos and alkalinities from 6.2- 21.3 mg/l. Measured pH values were near neutral and ranged between 6.51-7.52. Within the Paul Stream watershed, the smaller streams generally had lower alkalinities (less than 10 mg/l). Dennis and Notch Pond brooks had significantly higher alkalinity than all the other stream sites.

Fish Assemblages

A total of 1,763 fish from 20 species were collected from ten stream sites. In addition, a collection conducted by the VDF&W on lower Paul Stream (river mile 3.1) tallied 124 Atlantic salmon and 10 brook trout and an undetermined number of non-game species.

Of the 10 sites sampled in the West Mountain Wildlife Management Area (WMA), six could be evaluated for biological integrity using one of the two IBIs. The North Branch Paul Stream site supported only brook trout (to apply the CW-IBI there must be at least two species). Two sites on Paul Stream were Type 4 - low gradient- sand bottom sites (no appropriate IBI has yet designed to apply to this type of site). One site was only sampled qualitatively for species presence and, therefore, the data were not of sufficient quality to generate a score. Where IBI scores could be calculated, scores ranged widely for the six sites: 31 (“good”) to 45 (“excellent”). All sites where an IBI was calculated met the State Water Quality Standard biocriteria for fish assemblages of Class B waters.

Macroinvertebrate Assemblages

A total of 147 taxa were identified from the seven stream sites sampled within the West Mountain WMA. Aquatic insects were the dominant macroinvertebrate class with 131 taxa, broken down by Insecta order as follows: 52 Diptera (37 Chironomidae), 31 Trichoptera, 16 Ephemeroptera, 15 Plecoptera, 7 Coleoptera, 6 Odonata, 2 Megaloptera and 2 Hemiptera. The remaining taxa were mainly from the Gastropoda (5) and Bivalvia (4). This should not be considered even close to a complete taxa list of the running waters from the West Mountain WMA.

The integrity of the macroinvertebrate assemblage was evaluated from six of the seven stream reaches. The stream reaches from the Paul Stream drainage were assigned into an assemblage type based on stream size, elevation and alkalinity. Three of the stream reaches were considered to be Small High Gradient streams, and three Medium High Gradient streams. The seventh, Paul Stream (river mile 12.8), is a slow, meandering stream that appears to be of good biological integrity but could not be quantitatively evaluated using VDEC protocols. The biological integrity from two of the Small High Gradient streams was rated as excellent or within the range of natural condition. Dennis Pond Brook was rated as very good and may have been a result of the natural influence of significant wetlands and a pond immediately upstream from the reach sampled.

## Chapter Six: Wetlands Assessment

### Background

Vermont wetlands are significant resources that contribute to the economic, cultural, and physical well being of its residents. Wetlands provide numerous ecological functions and social values, including habitat for fish and wildlife, recreational and educational opportunities, habitat for threatened and endangered species, temporary storage of flood waters, and they aid in the maintenance of water supply and quality. However, these resources have been significantly affected by human land and water use activities.

The Department provides comment on Act 250 applications that involve wetland issues. The Department also conducts pre-Act 250 determinations to assist potential developers in meeting the requirements of the Act. Staff provide comment and advice to other state agencies and they are called upon as wetland experts wherever testimony is deemed appropriate. The Department reviews projects that involve wetland filling under Section 401 of the Clean Water Act based on compliance with the Vermont Water Quality Standards and other applicable provisions of State law. On January 23, 1996, the Vermont Water Quality Standards included the statement that the Standards shall apply to "all waters of the United States," as defined in 40 C.F.R. §122.2 (1995). This wording, therefore, includes wetlands as being part of "all water..." with respect to having met the goals of the Water Quality Standards.

### Extent of Wetland Resources

Recently, the Agency of Natural Resources digitized all the National Wetland Inventory (NWI) maps for the state. For Vermont, a total of 232,000 acres of palustrine wetlands is depicted in the maps. Until a more accurate figure has been determined, Vermont has used the figure of 300,000 acres of wetlands of all types. Wetland inventories conducted in selected towns around Vermont indicate there is considerably more acres of wetland in Vermont than was identified by the NWI project.

### Wetland Loss

A recent analysis of all completed projects reviewed by the Department shows that there has been a total of 522 acres of documented wetland loss and impairment over the period 1990 through 1999 (see Table III.6.1 below). No comparable project information is available for the years 2000 and 2001. The analysis was based on the Wetland Program's database which tracks wetland losses associated with projects reviewed by the program. Only Class 3 wetlands under review for 401 Water Quality Certification, Act 250 or voluntary review are included in this table.

These figures do not represent all wetland impacts as they are based only on summaries of projects that have been completed for each year. It is likely that many of the projects that have not been completed are larger projects and may represent substantial areas of wetland impacts. Also, it is clear that there are many wetland alterations still occurring that are not reported to the Department and are not included in this database.

**Table III.6.1. Acres of Wetland Loss and Impairment 1990 through 1999[1]**

| | '90 | '91 | '92 | '93 | '94 | '95 | '96 | '97 | '98 | '99 |
|---|---|---|---|---|---|---|---|---|---|---|
| **No. of Completed Projects** | 474 | 482 | 559 | 454 | 393 | 377 | 321 | 368 | 359 | 328 |
| **Acres of Wetland Loss** | | | | | | | | | | |
| Class One & Two Wetlands | 19.4 | 12.1 | 11.7 | 19.1 | 4.0 | 5.9 | 5.3 | 4.8 | 2.9 | 3.5 |
| Class Three Wetlands | 22.4 | 10.0 | 8.0 | 11.6 | 6.6 | 12.2 | 9.7 | 7.1 | 4.6 | 4.7 |
| **Acres of Wetland Impair.** | | | | | | | | | | |
| Class One & Two Wetlands | 47.8 | 40.2 | 111.3 | 19.0 | 24.6 | 30.9 | 4.3 | 3.7 | 3.2 | 16.8 |
| Class Three Wetlands | 3.1 | 7.8 | 7.2 | 4.6 | 10.5 | 4.0 | 8.9 | 1.6 | 1.4 | .49 |

The database analysis also shows that there were over 500 acres of wetlands saved during the 1990-1999 period. This was achieved by encouraging developers to move their projects out of wetlands or to reconfigure them so as to have little or no impact on wetlands.

**Wetlands Protection Mechanisms**

On October 15, 1997, the State of Vermont and the US Army Corps of Engineers issued the State General Permit for projects in waters of the United States that occur in Vermont. Under this program, any fill under 3,000 square feet (except in Class Two wetlands, or special wetlands, or wetlands adjacent to international bodies of water, or in the towns of Athens, Brookline, Grafton, Newfane, Putney, Rockingham, or Townshend) do not have to report their fill activity to either the Corps of Engineers or the State of Vermont. Fills between 3,000 square feet and 43,560 square feet (one acre) are reviewed by an interdisciplinary team. The Vermont Water Quality Standards are the basis for review of projects under Section 401 Water Quality Certification. The Vermont Water Quality Standards do not specifically address wetlands. The Standards address discharges to open water and impacts to surface water which are used by the Wetlands program to evaluate wetland impacts. The Department works closely with the US Army Corps of Engineer's Vermont Field Office staff on many projects.

A Conditional Use Determination (CUD) is used to allow reasonable development in and around wetlands while protecting the functions and values of this natural resource. CUDs are issued by the Vermont Wetlands Program only when it is determined that undue adverse impacts will not result from a proposed project.

Geographically, Chittenden County is the area of the state with the highest acreage of wetland alteration (refer to Figure III.6.1). Chittenden County remains the area of the state with the largest number of Department site visits and the largest area of wetland loss.

For projects completed during the 1990-1999 period, the Department's database shows that of the project types, public projects (164 acres) and commercial/industrial development (214 acres) resulted in the greatest area of wetland loss and impairment, followed by 127 acres from agriculture projects and 116 acres from pond construction (refer to Figure III.6.2). Commercial/industrial development,

[1] Figures are based on the projects that have been completed. (Source: Wetlands Office Database).

residential development and road construction generally result in mostly wetland loss with small areas of wetland impairment.

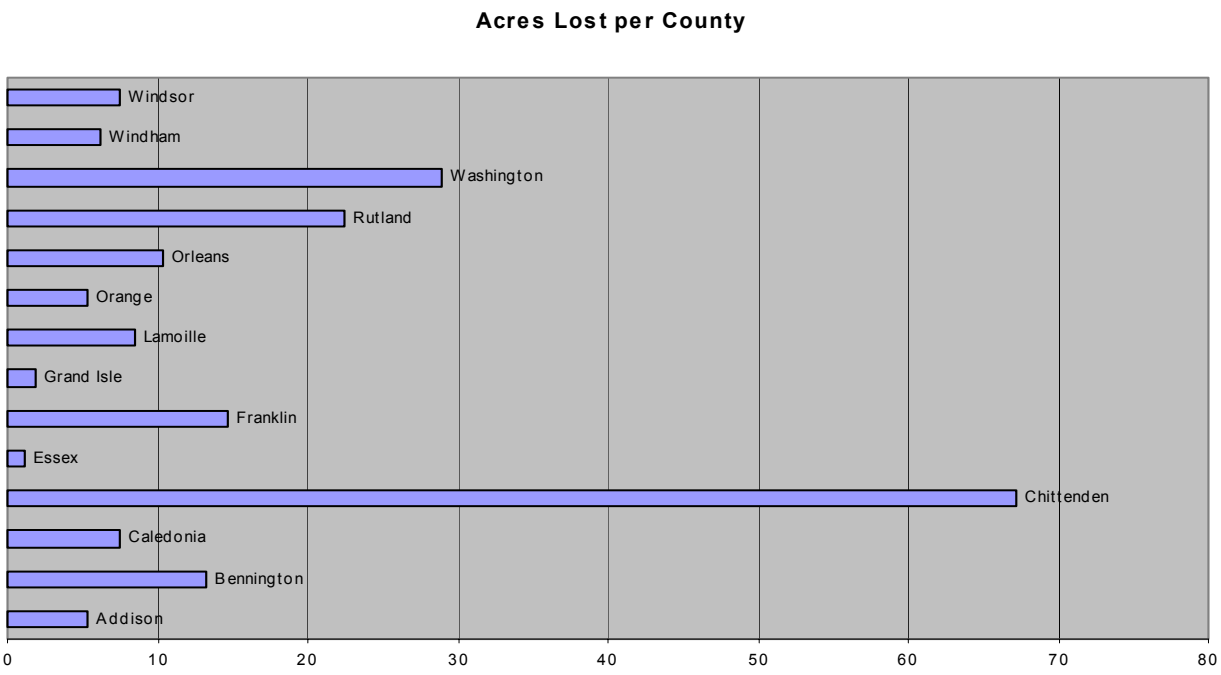


Figure III.6.1. Wetland loss, 1990 to 1999.

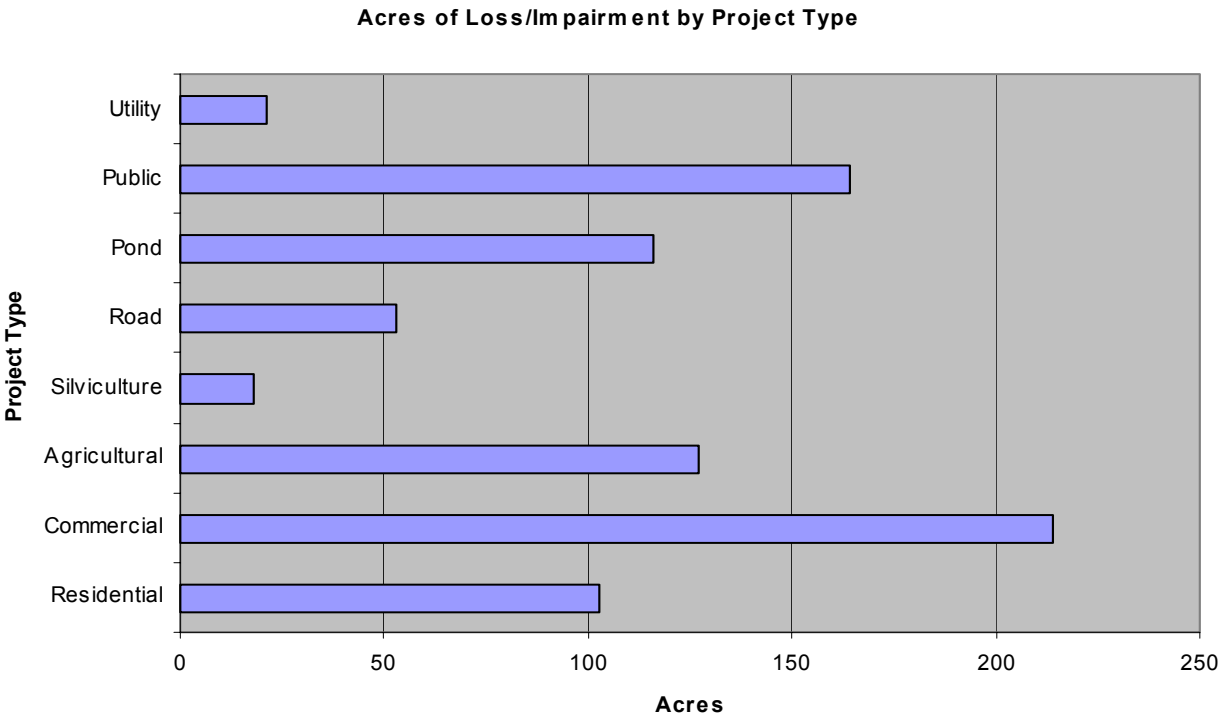


Figure III.6.2. Wetland loss by project type, 1990-1999.

Figure III.6.3 below shows the area of wetland loss and impairment over the period 1990 to1999 based on the functions identified to be present in each altered wetland. A particular wetland, where an alteration occurred, may provide one or many of the ten functions and values listed, the documented area of alteration for that wetland is included in the totals for each function and value provided by that wetland. The surface water quality protection and wildlife habitat functions were the most commonly occurring functions in altered wetlands.

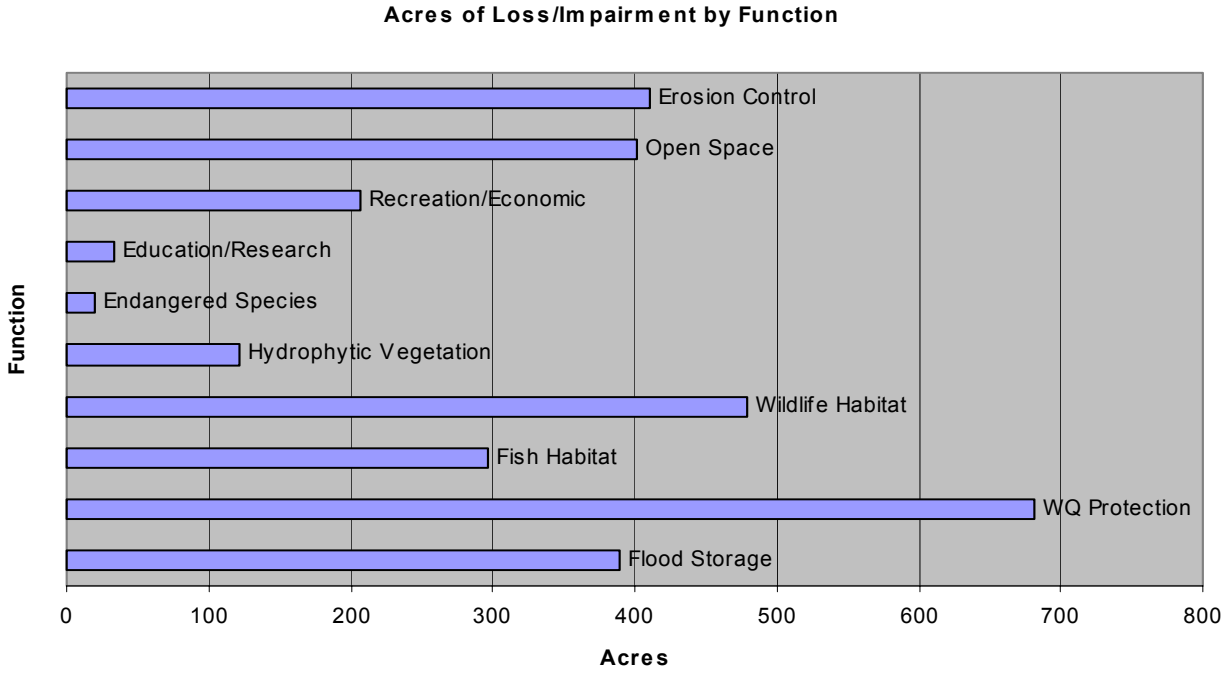


Figure III.6.3. Wetland loss in relation to wetland function, 1990-1999.

Table III.6.2, found on the following page, shows the percentage of projects reviewed by the Vermont Wetlands Program by wetland type. As shrub swamps are the most common wetland type, this type has the highest percentage of project. Emergent marsh and forested wetlands have the next highest percentage of projects.

In 1999 VDEC began carrying out a biomonitoring project. The focus of the project is to investigate biological indicators of the health of vernal pools and cedar swamps. The project goal is to describe 20 reference sites. The characteristics (metrics) that have been studied include macroinvertebrates, reptiles, amphibians, algae, and plants. The project included study of the land 492 feet (150 meters) around vernal pools to characterize the buffers. The study of cedar swamps was similar but the emphasis will focus on plants and birds as potential indicators. The data for the biomonitoring project has been collected, and the next step will be to analyze it. The project is unique because it is a multi-disciplinary study involving programs from Vermont Department of Fish & Wildlife, the Biomonitoring and Aquatic Studies Section (BASS) and the Wetlands Office.

**Table 6.2. Percentage of Projects by NWI Wetland Type.**

| NWI Wetland Type | Type Description | Percentage of Projects |
|---|---|---|
| PEM | palustrine - emergent | 17.7 |
| PFO/PEM | palustrine - forested/emergent | 1.5 |
| PFO/PSS | palustrine - forested/scrub-shrub | 8.0 |
| PFO1 | palustrine - forested (broad leaved deciduous) | 17.6 |
| PFO2 | palustrine - forested (needle leaved deciduous) | 0.7 |
| PFO4 | palustrine - forested (needle leaved evergreen) | 3.5 |
| PFO5 | palustrine - forested (dead) | 0.2 |
| POW | palustrine - open water | 12.8 |
| POW/PEM | palustrine - open water/emergent | 1.3 |
| POW/PFO | palustrine - open water/forested | 0.2 |
| POW/PSS | palustrine - open water/scrub-shrub | 0.3 |
| PSS/PEM | palustrine - scrub-shrub/emergent | 14.4 |
| PSS1 | palustrine - scrub-shrub (broad leaved deciduous) | 21.1 |
| PSS3 | palustrine - scrub-shrub (broad leaved evergreen) | 0.7 |

The Wetlands Office has again sponsored work on bio-control of purple loosestrife. The goal of the program is to reduce purple loosestrife in Vermont by 90%. To accomplish this goal, the program's work has been divided into three main aspects: biological control, documentation of purple loosestrife populations, and education and outreach. Since 1996, approximately 193,792 beetles have been released on 669.25 acres of land throughout Vermont. In 2001, approximately 52,889 beetles were released on 97.35 acres of land. An ongoing monitoring program was also initiated and has enlisted the help of the Vermont Agency of Transportation. Through education and outreach, the program strives to help prevent the intentional spread of purple loosestrife by informing the community of the consequences of this invasive species.

The Department assisted in the planning of several voluntary wetland restorations and protection projects in cooperation with Natural Resources Conservation Service, EPA, the US Army Corps of Engineers and other programs. One project in the West Rutland Marsh complex will eventually restore 145 acres of wetlands through the restoration of natural hydrologic conditions in the area. Another project in the Whiting Swamp area will restore 45 acres of wetland forests along the Otter Creek. A third project along the Lemon Fair River will protect 39 acres of emergent palustrine and riverine wetlands through purchase. Lastly, another site of 35 acres of emergent and riverine wetland was purchased along the Lower Otter Creek with the assistance of the state waterfowl startup funds. The

Vermont Wetlands Program offers technical and permitting assistance for wetlands restoration purposes.

Education is an important approach in dealing with issues related to beaver populations in Vermont. Because beaver activity result in changes to water levels, many conflicts between landowners, local road commissioners and beavers have arisen. The state has been spending an increasing amount of time solving before and after-the-fact problems with beaver dams. The state has organized a task force to study the issue and provide recommendations. The study report has been drafted and it is in the process of review. Other education efforts include developing an Educational Plan with the Water Resources Board. The Program has also coordinated with the Agency of Transportation to address routine maintenance issues such as ditching and culvert replacement. The agricultural community has benefitted from workshops developed by NRCS, the Army Corps of Engineers, Conservation Districts and the Wetlands Program.

## Chapter Seven: Public Health / Aquatic Life Use Concerns

*Size of Water Affected By Toxicants*
Outside of fish consumption advisories discussed below, there are currently no waterbodies where toxicants are known to be impairing uses related to public health. NPDES and water supply monitoring continue to provide information related to environmental occurrences of toxicants in permitted municipal and industrial discharges and public water supplies respectively.

*Changes to Fishing Advisory*
Vermont's Fish Advisory was last updated in June 2000. Prior to this, existing special advisories were in place, warning against consumption of: walleye from several Vermont lakes and ponds; large lake trout from Lake Champlain; and, most fish in Grout Pond and Somerset, Harriman, Sherman and Searsburg Reservoirs. During the reporting period, two new reservoirs, Moore and Comerford Reservoirs, were identified as having particularly elevated concentrations of mercury in resident fish. These reservoirs are located along the mainstem of the Connecticut River, and are power generating hydroelectric facilities which are in the process of final FERC re-licensing as part of the Fifteen Mile Falls Hydroelectric Project. These reservoirs have been specifically identified in the new advisory. Vermont's current Fish Advisory (see Appendix B) is also available online at http://www.state.vt.us/health/record/fish.htm.

*Cyanobacteria*
While not necessarily a pollutant, the occurrence of toxic strains of blue-green algae (cyanobacteria) in Lake Champlain has generated some concern over the last three years. The University of Vermont, in collaboration with several state and federal agencies, has been assessing the risks related to the occurrence of cyanobacteria in Lake Champlain and reports results in a report for the Lake Champlain Basin Program and the Centers for Disease Control, entitled "*Evaluation of Potential Blue-Green Algal Toxins in Lake Champlain - Summer 2000*" (Barry H. Rosen Ph. D., USDA-NRCS, Watershed Science Institute et al 10/9/2001 with Angela Shambaugh. Lisa Ferber. Felicity Smith, Mary Watzin (Ph. D.), Cathi Eliopoulos, and Peter Stangel). Additional assessments were made during the summer of 2001.

*Current Use Pesticides*
A collaboration of the University of Vermont, the Vermont Department of Agriculture, Food and Markets, the Vermont Pesticide Advisory Council, the US Geological Survey, and the Department conducted an initial screening of the occurrence of selected current use pesticides in storm water from urban and suburban areas. Initial results were reported in "Pesticides in the Surface Waters of Chittenden County " (see Appendix G). The collaborative effort is continuing assessment activities in and around Chittenden County and Lake Champlain.

*Small Community Untreated Waste Discharges*
Several small communities throughout the state have been discharging untreated wastes to the state's waters due to the lack of treatment facilities. The discharges from these areas constitute threats to public health. Included are the villages of East St. Johnsbury, Pownal and Warren. The Department is providing technical assistance to these communities to help them plan for the installation of appropriate wastewater treatment facilities. Two municipalities (Shoreham and Cabot) where similar discharges had been discovered are now significantly advanced in the pollution abatement process.

Wastewater treatment facilities have been constructed in each community and wastewater discharge permits have been issued.

*Sites of Known Sediment Contamination*

Previous 305b reports identified toxic contamination in Lake Champlain sediments. While no new information is available regarding these well-characterized sites, one new sediment contamination site was identified during the reporting period. This site is located on the east shore of South Bay in Lake Memphremagog, adjacent to a drain which channels runoff from a railyard. Within the one-acre area of contaminated sediments, very high concentrations of cadmium, lead and total petroleum hydrocarbons have been measured. Toxicity testing of the sediments from this area produced up to 95% mortality relative to controls for multiple organisms. The site has an open hazardous waste site file and is being managed by the Department's Waste Management Division. The area of influence of the contaminants has been determined to be one acre, and the remediation plan includes removal of the contaminated sediment. VDEC issued a permit for this activity in September 2001 and remediation is expected to take place in 2002. This site is presently on the Vermont list of Priority Waters Needing Assessment ("Part C list"). The discharge was stopped in 1992, but the site did not recover and recent follow-up site assessments have determined that aquatic habitat in the area remains impaired. The Lakes and Ponds section has determined that the site should remain on the "C list" pending follow up assessments after the sediments have been removed.

*Restrictions on Bathing Areas*

Table III.7.1 below summarizes certain Lake Champlain beach closures for the reporting period due to non-toxics (i.e. high E.coli bacteria counts).

**Table III.7.1. Closures of Bathing Areas Due to Non-toxics.[2]**

| Waterbody/Swim Area | Dates of Closures |
|---|---|
| Leddy Beach, Burlington | July 18th, 2000 |
| North Beach, Burlington | July 18th, 2000 |
| North Beach, Burlington | August 21st, 2001 |
| Bayside Park, Colchester | June-August, 2001 (12 days) |

*Restrictions on Surface Drinking Water Supplies*

There were no closures of surface drinking water supplies during the reporting period; however, there were 5 boil water notices issued for the period. The Allen Point Water Supply and Rutland Town Mendon FD 2 systems are under indefinite boil water notices due to system deficiencies which have been in effect since September 1987 and January 1971, respectively. Table III.7.2 below lists the boil water notices which were issued by VDEC's Water Supply Division to systems with surface water sources.

[2] During the summer of 2000, a portion of the White River located downstream of the Bethel Wastewater Treatment Facility was closed to swimming uses due to the failure of the facility's disinfection system.

**Table III.7.2. Boil Water Notices, January 1, 1998 through December 31, 1999.**

| Water System Name | Source |
|---|---|
| Allen Point Water Supply | Lake Champlain |
| Bolton Valley Water and Sewer | Joiner Brook (and East Branch of same) |
| Greensboro FD#1 | Lake Caspian |
| Newbury Village Inc. | Unnamed reservoirs |
| Rutland Town Mendon FD2 | Tenney Brook |

*Fish Kills (3)*

The Department is aware of three fish kills which impacted fish communities in Vermont during the reporting period. The first of these occurred in June 2000 on Lake Carmi. The incident was classified by VANR's district fisheries biologist as 'moderate' with a variety of species involved. The fisheries biologist attributed the incident to natural post-spawning stress. Lake Carmi is impaired due to excessive algae blooms caused by excess nutrients. It is unclear whether there exists a linkage between poor water quality at Lake Carmi and the observed fish kill. Minor annual fish kills involving brown bullhead are common at Lake Carmi.

On August 13, 2000, a massive fish kill resulted from a catastrophic fire which destroyed a feed mill on the Missisquoi River in Troy, Vermont. The Old Mill Inc. was located directly on the banks of the river and ensuing firefighting efforts caused the release of unknown quantities of both copper sulfate and zinc compounds (e.g. $ZnPO_4$ and $ZnSO_4$). As Troy, Vermont is adjacent to and directly upstream of the Canadian border, the effect of the release caused the death of thousands of fish of numerous species which was first noticed in Canadian waters. US EPA and VDEC spill response personnel were on the scene by Monday and contaminated runoff from firefighting was prevented from leaving the site. By this time, residents as far downstream as East Berkshire, Vermont were notifying VDEC of foul odors and the presence of occasional dead fish in the river. Initial monitoring data from waters immediately downstream of the burned mill showed total recoverable copper and zinc at 225 ppb and 227 ppb, respectively. Site-specific acute criteria for copper are 9.2 ppb and 6.5 ppb for zinc. In Richford, Vermont the maximum observed copper concentration was approximately 12 ppb. Follow-up monitoring data collected by Canadian investigators and VDEC personnel showed that copper concentrations declined to below criterion limits within one week after the event. The river was closed to all uses as far downstream as Richford for the week following the release. The site was cleaned up as soon as safely practical after the fire was completely extinguished and Canadian biologists reported that fish were re-populating the affected reaches of the Missisquoi River, presumably from tributary refugia, shortly thereafter.

Finally, during the early to mid-summer 2001, there was a major fish kill on Lake Champlain. This incident was first observed in the South Lake section of Lake Champlain and appeared to be specific to white perch. Later in the summer, dead and dying fish of a variety of species exhibited similar symptoms in more northern sections of the lake. The fish kill was investigated by VANR's fish pathologist, and was determined to be caused by a naturally occurring parasitic bacterium *Columnaris sp.* Early-season rapid temperature fluctuation in the lake, related to the long winter followed by a rapid changeover to summer conditions, was identified as a key factor which predisposed Lake Champlain fish to the bacterium *Columnaris sp.*